SPATIO-TEMPORAL PATTERN OF URBAN SPRAWL IN ZARIA URBAN AREA, NIGERIA (1976-2014)

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DECLARATION

I declare that the work in the thesis entitled ‘Spatio-Temporal Pattern of Urban Sprawl in Zaria Urban Area, Nigeria’ has been performed by me in the Department of Urban and Regional Planning under the supervision of Dr. M. Sani and Mal. A.R. Mukhtar.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

…….. …… ……

Name of Student Signature Date

CERTIFICATION

This thesis entitled 'SPATIO-TEMPORAL ANALYSIS OF URBAN SPRAWL PATTERN IN ZARIA URBAN AREA, NIGERIA' by Shuaibu Abdulaziz Kugu meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This research work is dedicated to my mother, Hajia Binta Shuaibu.

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ABSTRACT

Urban sprawl, or the unplanned and uncontrolled spreading out of built-up areas in Zaria urban area causes problems of congestion, poor urban basic infrastructure, delivery and poor urban planning. This study analyzed the pattern, causes and implications of urban sprawl using GIS and Remote sensing as an improved approach to analyze and explain sprawling beyond the traditional spatial or cartographic mapping and monitoring method which lacks the effectiveness to analyze and explain the details of spatio-temporal dimensions of urban sprawl. Map overlay analysis was used to calculate the rate and magnitude of the growth pattern for the four epochs of 1976, 1990, 2000 and 2014 if it could be regarded as sprawl. Results revealed that ribbon and leap-frog pattern of sprawl had fully developed North-South at approximately 25km stretch (Kano-Kaduna road) and 16km East-West on the regional arterial roads (Sokoto road and Jos road). Findings also revealed that the sprawl patterns were as a result of rapid urban population growth, increase demand for land, poor urban planning and social segregation with their respective implications. The causes of having such widespread urban sprawl needs to be studied in order to control the City's growth.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Planning is a decision making method that aims at achieving a desired goal with a given resource and time frame. Urban planning should be viewed in this context particularly with the objectives of addressing the prevailing socio-economical and physical problems of the given town (Haimanot, 2009).

The accurate definition of urban sprawl may be debated but a general consensus is that urban sprawl is most simply defined as the spreading out of a city and its suburbs over more and more rural land at the periphery, driven by multitude of processes and leading to inefficient resource utilization (Bullard, 2000). Urban sprawl has become a negative term without any serious examination of its qualities or benefits and without any critical analysis of its troubled alternative urban congestion while the formation of the world's cities has always been determined by the means of transport available (Abimbola, 2008).

Due to rapid population growth and urbanization, there has been a rapid rate of sprawl in urban areas globally. As the population increases to accommodate this growth, the resultant effect is sprawl mostly at the fringes or highways. This phenomenon has led to the loss of agricultural land, open spaces and ecologically sensitive habitat. Other negative impacts of urban sprawl are; increase in automobile transportation, congestion, economic segregation and air and water pollution among others (John, 2006).

Urban sprawl is not entirely a bad phenomenon. Some positive impacts of urban sprawl are; increased satisfaction of housing preference and generation of an increased number of suburban local governments which are likely to have lower crime rate and better schools (John, 2006).

Urban sprawl is formed as a result of the development pattern which brings about implications on the city and its management causing excessive land consumption due to undervaluation of open space, congestion due to increased commuting and socio-economic segregation due to exclusionary housing market. Sprawl development is now perceived as contributing to fiscal costs for providing infrastructures and public health problems (Carruthers and Ulfarsson, 2002).

1.2 STATEMENT OF RESEARCH PROBLEM

Socio-economic effects of urban sprawl have been shown to be highly inefficient especially in the provision of services and infrastructure by local governments. While the societal effects of urban sprawl are reduced social equity, negative health impact, segregation and inability to adapt to changing lifestyles. Deal and Schunk, 2004 in (Duany et. al, 2000).

In a developing country such as Nigeria, development in urban areas and miscellaneous landuse types are isolated in the fringe areas followed by gradual filling of intervening spaces with similar uses, this is mainly due to rapid growth in population size which is usually uncontrolled. Urban Sprawl is a growing concern of citizens, environmental organizations and governments.

Zaria urban area has been experiencing sprawl over the years due to its increase in population which had led to rapid expansion that had left profound changes on the landscape in terms of land use and land cover. Zaria urban area is a host to several government educational institutions which attracts rapid influx of migrants from all over the country in search of food, shelter, better education and job opportunities.

The direction of expansion is observed to be towards the major roads such as Kaduna-Kano expressway, Zaria-Jos road, Zaria-Birnin Gwari road and Zaria-Sokoto road in a ribbon spread pattern. Some Areas in Zaria like Gaskiya, Hanwa, Zango are characterized by sporadic growth and few scattered development. Discontinuous urban growth is also posing a problem of Land speculation.

Urban sprawl in Zaria urban area is characterized by physical and socio-economic problems such as traffic congestion, loss of open spaces, segregation, very poor infrastructure, and lack of basic facilities in the sprawled areas, loss of vegetation land and increased air pollution and water pollutant runoff into natural waterways.

The issues being examined by the pattern of development in Zaria as sprawl brings about urban management implications to the management of Zaria urban area. The study seeks to analyse the pattern and determine the implications of urban sprawl in Zaria.

Various studies have been considered on different aspect of urban sprawl which includes Mohammadi, et al (2012), focused on finding the existing pattern of Urmia and the effective factors on such pattern. Another study on sprawl by Aliyu, (2011) focused on examining the pattern and urban management implications of urban sprawl in Kaduna Metropolis through the development and application of an integrated tool of sprawl analysis. Also taking into consideration is the study by Ahmad, 2015 which focused on simulating urban growth in Zaria urban area.

This study focuses on the analysis of the pattern of sprawl in Zaria urban area and its implications on urban management which haven't been studied in Zaria. The result of the

research is expected to guide growth in a more ecologically sustainable fashion and assist the study area in attaining the intended spatial design and land use intensities.

1.2.1 RESEARCH QUESTIONS

1. What is the pattern and causes of urban sprawl in Zaria urban area?
2. What are the implications of urban sprawl to the study area?

1.3 AIM

The study aims to analyze the pattern and urban management implications of Urban sprawl in Zaria Urban Area towards making appropriate Urban management recommendations.

1.4 OBJECTIVES

1. To review the concepts, characteristics of urban sprawl and the techniques for its analysis.

1 To analyze the pattern of urban sprawl in Zaria urban area and establish its causes.

2 To establish the urban management implications of urban sprawl in Zaria urban area.

3 To make appropriate urban management recommendations in solving urban sprawl issues.

1.5 SCOPE AND LIMITATION

The scope of the study was on the pattern and implications of urban sprawl in Zaria Urban Area, and the limitation was the inability to acquire higher resolution imageries and differences in resolution. Landsat image of 1976 was acquired with the multi - spectral scanner (MSS) which has a spatial resolution of 80 meters, whilst the images of 1990 and 2000 were acquired with Thematic Mapper ™ and Enhanced Thematic Mapper (ETM) respectively. These both have a spatial resolution of 30 meters. Although this limitation was corrected for through image

thinning of the 1976 using Edras. Apart from this, it produced an arbitrary classification of water body for the 1976 classification.

1.6 SIGNIFICANCE OF STUDY

The expected study findings will disclose the problems encountered regarding the volume of urban sprawl in Zaria urban area. The knowledge is to improve on the issues of controlling urban sprawl. The study was also remarkable to other researchers for their in-depth knowledge acquisition on urban sprawl issues, literature reviews and urban management recommendations for urban sprawl.

1.7 THE STUDY AREA

1.7.1 Geographical Location

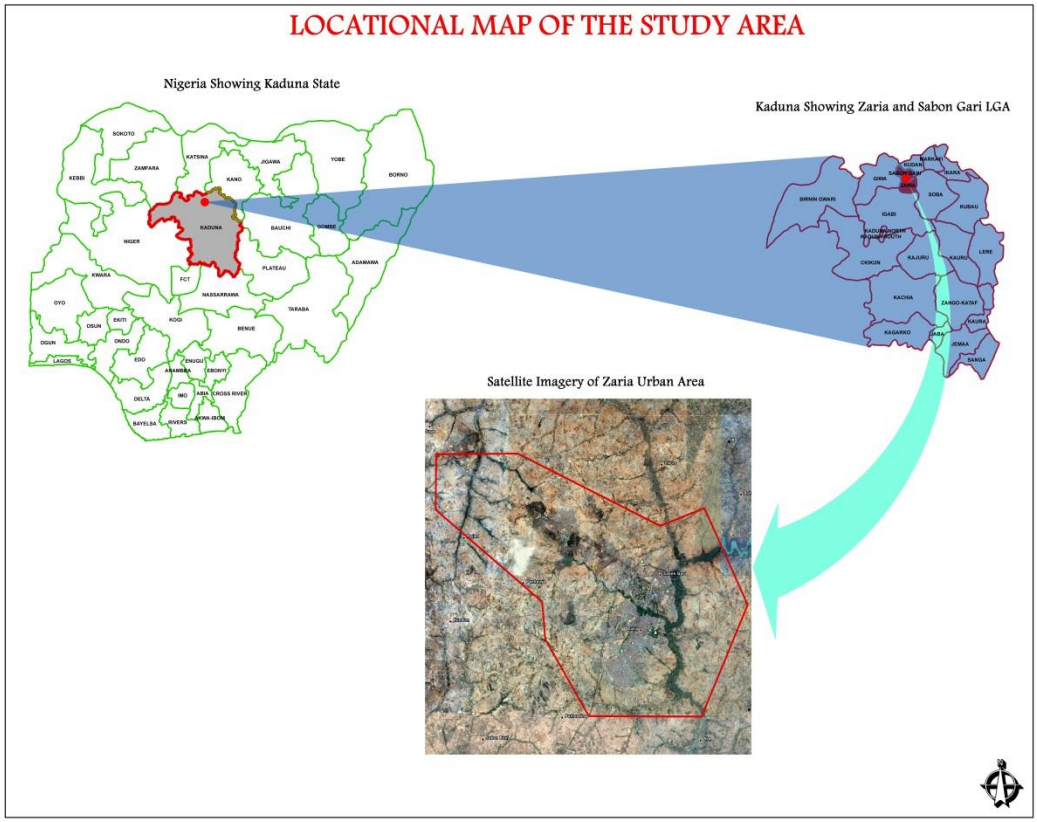
Zaria Urban area is located between latitude10˚57’36’’N and 11˚15’32’’N and 7˚39’00’’E and 7˚53’02’’E. It is made up of it Sabon Gari and Zaria local government areas and some parts of Giwa Local government area like Shika about from Ahmadu Bello University main campus, Samaru (Oladimeji, 2012). The population of Zaria is approximately 975,153 (projections from 2006 national census).

Zaria Urban Area is bounded by Kudan to the North, Igabi to the South, Soba to the East and Giwa to the West. Zaria is about 26 km from Kudan, 50 km from Igabi, 40 km from Soba and 29 km from Giwa.

It is defined by a 15Km radius from the PZ post office and is well connected by roads and railways with other regions of the country. Distances from Kaduna, Kano, Jos and Sokoto are approximately; 75Km, 176Km, 387Km and 404km respectively. Zaria is the second principal

town in Kaduna state and home to the Ahmadu Bello University, and a host to several other federal government institutions.

Figure. 1.1: Locational Map of the study area



Source: Author, 2015

In Zaria Urban Area, a railway line running from the south-west cross river kubanni into the town. It has siding at square 6027, and then bifurcates at square 6028 where it has a station (Sabon Gari Railway Compound). A branch line runs north-west wards to Funtua, while the other runs north-east across River Galma to Kano. All trains going to Kano, Gusau and Malumfashi are diverted from Zaria junction that is why it is an important nodal point for the railway system.

Similarly, the major roads (Kaduna, Sokoto, Bassawa and New Jos Roads) running south-west wards, north-west wards, north wards and east wards links Zaria Urban Area to important towns like Kaduna, Funtua, Kano and Jos which also makes it an important nodal point for the road system. According to the existing Zaria Master Plan (1979) Zaria Urban Area falls on the north-south axis by road, connecting Lagos to Kano and also part of Niger.

1.7.2 Weather and Climate

Zaria area poses a tropical continental climate, the area is characterized by distinct wet and dry season. The seasonality is determine by the movement of the inter-tropical convergence zone (ITCZ). Four seasons based on temperature and rainfall are identify. This is cool dry season (May/June-September) and a season of decreasing and falling temperature end of September to late November. Rainfall starts from May to September with its peak in August. It is of convective type with thunder storm at the beginning and end of the rainy season. With an annual rainfall of about 1000mm, the length of the rainy season is between 150±10 days. Temperature over the area is higher than 27°C over the years (Oladimeji, 2012).

1.7.3 Vegetation

The vegetation of Zaria is of Northern guinea Savanna, which is characterized by well-developed grass layer of tufted. The vegetation has being modified by man. It climatic climax was to be a deciduous forest but human influence have interfere with it and the whole area has been stripped of its natural vegetation. The dominant tree species are Isoberlina doka, Isoberlina tomentosa, uapacca togoenis, parkia clapertoniana vitex doniana and so on. Other tree species are those deliberately planted by man and are of high economic value, this include magnefera indica, ceibs penttendra, termirindus indica and other exotic tree species.

The vegetation is scattered and are interspersed with grasses, which are usually brown during the dry season. The trees here are deciduous and adoptive feature include thick bark, long tap root, modify leaves etc (Oladimeji, 2012).

1.7.4 Soil

The soil in Zaria area belongs to the tropical soils, and can be attributed to the geology and climate of the area. A tropical soil profile of the area shows distinct differentiation of horizon, and deposits of concretion noodles and mottles underlying the horizon. Some of the soil near the inselbergs may be considered as weakly developed while in the fadama area, are hydromophic soils. In the valley bottom land, vertisols are common, and overlain by transpoted alluvial soils. The fadama soil are seasonally flooded and are mostly dark gray with very poor drainage. The profile also shows the accumulation of clay between a depth of 36-119 cm, below the horizon of clay accumulation is one of iron accumulation and impotant defect of such soil is that very heavy rain surface caps which are impermeable are formed (Oladimeji, 2012).

1.7.5 Drainage Systems

Zaria is being drain by three great rivers, which are Galma, Kubani and Saye river. River Galma is perennial, and is located in the northeast direction. The other two are seasonal. River Galma is a major tributary of river Kaduna with a drainage basin of about 300Km² in area. It is a major source of water for irrigation and also for domestic use.

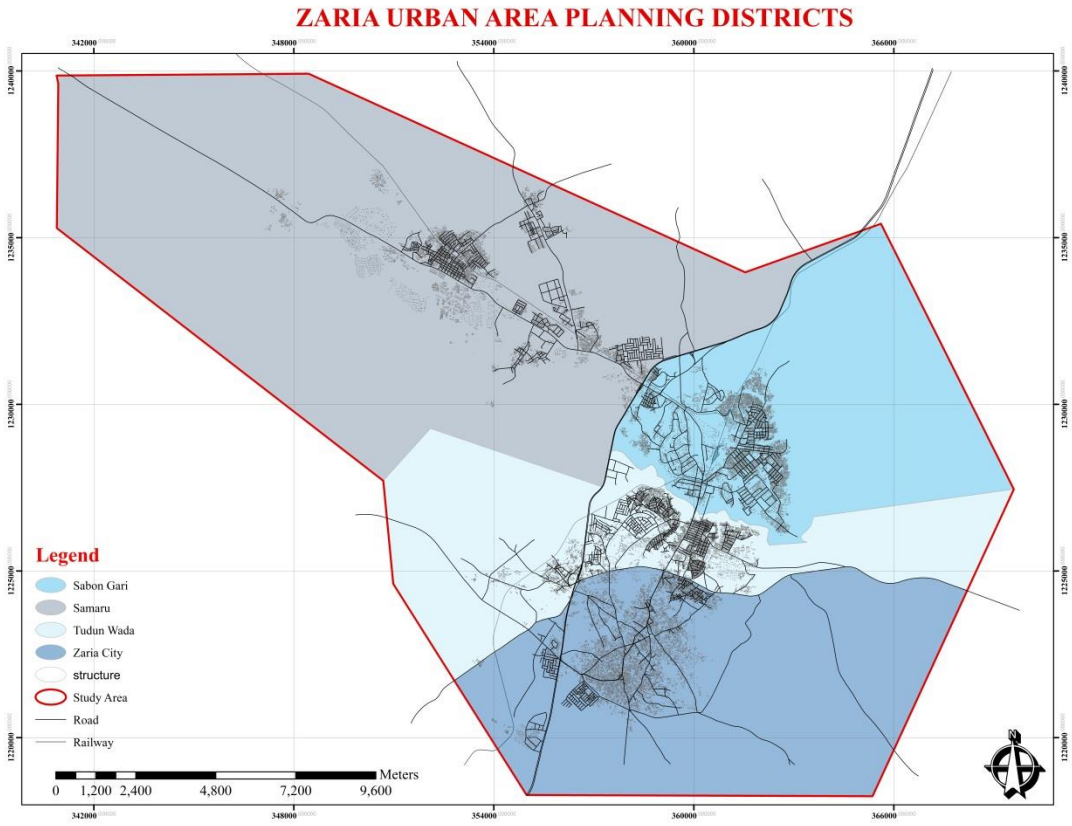
The area is characterized by two type of drainage basin, base on stream frequencies and drainage density. The first one is characterized by a large number of unbranched first order tributaries, producing high stream frequencies and drainage densities such basin are characterized by gulling and intense head water erosion. The second type consists of the basin with low stream

frequencies and drainage densities e.g Kubanni to the east of Zaria. The valley bottoms here contain wide marshy flood plain meanders. The drainage patterns are commonly dendritic, reflecting the absence of structural control over the drainage channels on their deeply weathered plains.

1.8 Physical Form of Zaria

The present day Zaria is presently made up of four planning districts -Zaria city, Tudun Wada, Sabon Gari and Samaru.

Figure 1.2: Planning district of Zaria urban area



Source: Author, 2015

1.8.1 Zaria City

Zaria city, which is the headquarters of the Zazzau Emirate, lies in the South of Zaria. The original walled city retains much of the physical character of the traditional indigenous settlement of the Muslim Hausa-Fulani population. The city still has a traditional character of perimeter wall, a complex maze of mud-walled compounds, and major roads secured by city gates (Kofas) leading to the Emir's palace (Fadar Sarkin Zazzau) at Babban Dodo, the Friday mosque, and the market area..

1.8.2 Tudun Wada

Tudun Wada is situated immediately North of the main city gate. It was the original strangers' quarters for non-natives of Northern Nigerian origin. Tudun Wada has a grid- iron street pattern which was laid out in 1914. It was part of the Emirs farm in 1904 which was later developed as a result of the colonial administration policy.

Its population growth owns much to the employment opportunities offered by establishments like Federal College of Education, ABU Institute of Administration, ABU Teaching Hospital and Kaduna State polytechnic. Several expansions have been made to Tudun Wada as it now extends to Gaskiya and Tudun- Jukun and Tukur- Tukur.

1.8.3 Sabon Gari

To the north of Tudun Wada lies Sabon Gari. Sabon Gari was created by colonial policy to house strangers from the southern parts of the country. It was built after the railway reached Zaria in 1911. It houses immigrants of mixed cultures and religions. Sabon Gari was laid out on grid- iron street pattern, which is indicative of an attempt at planning. The area is characterized by medium and low density residential plots. Later, areas like Muchia, Chikaji and Dogon Bauchi sectors were engulfed by development. Adjacent to Sabon Gari lays the Government Reservation Area (GRA). It is characterized by west European oriented urban design pattern. The roads are properly laid out, plots are mainly of low density and there are a lot of organized open spaces.

The Sabon Gari area is zoned to residential, commercial, industrial, health, education, and recreational uses. This district has now transformed to become the CBD of Zaria. The GRA was originally reserved exclusively for the British administrator but indigenous officers now occupy

the area. It has the Zaria club, Polo field, Race course, and Gulf club situated in it. After the GRA, moving northwards are few indigenous settlements of Kwangila, Hanwa, and Dogarawa.

1.8.4 Samaru

Samaru is a religiously and cultural mixed settlement. Samaru evolve from a small colonial farming settlement into a large community. Samaru village owes its growth to the influence of Ahmadu Bello University, National Institute of Leather Research Technology and the Institute for Agricultural Research. The settlement inhabited mostly by people working in the university. The settlement has expanded over time to include other settlement like Zango, Palladan, Layin Zomo and Bomo.

CHAPTER TWO

2.0 THE CONCEPT, CHARACTERISTICS, CAUSES, IMPLICATIONS OF URBAN SPRAWL AND METHODS OF ITS ANALYSIS

2.1 INTRODUCTION

The term urban sprawl is widely used in many disciplines dealing with urban development and urban form. It is moreover used as a current buzzword in urban politics as well as in the public discussion about the growth and form of cities. Since it is used by different disciplines and carries various meanings, the use of the term "urban sprawl" often leads to misunderstandings and confusion. The Michigan Land use leadership council (2005) states: "In the field of land use and planning, no other word spurs more controversy and confusion than sprawl". When it comes to writing a paper about sprawl, the controversy and confusion generates major problems. It is therefore necessary to give a broad and detailed theoretical overview about the phenomenon of urban sprawl, in order to sort out the various meanings and components of the terms involved, before one can begin any empirical analysis on the subject. Particularly, when it comes to measuring sprawl, a lack of understanding concerning the concept of sprawl impedes the application of the most appropriate methodological approach, and obtaining significant and valid results.

2.2 HISTORY OF THE TERM SPRAWL

The term "sprawl" was first used in 1937 by Earle Draper of the Tennessee Valley Authority in the context of a national conference of planners (cit. in Wassmer 2002). Sprawl was referred to as an unaesthetic and uneconomic settlement form. According to Wassmer (2002) the term "urban sprawl" was first used in the opening paragraph of an

article by the sociologist William Whyte in Fortune magazine in 1958. Planners have since then used the term to categorize an urban development, generating undesired social effects. Urban Economists also adopted the term and added to the debate terms like scatter, leapfrogging and ribbon development (explained later). The Real Estate Research Corporation inaugurated in 1974 the controversial debate on positive and negative effects of sprawl (Real Estate Research Corporation, 1974). In the 1990s the phenomenon of sprawl was adopted by other sciences as well as the general public in the US. At this time the Anti-sprawl-movement arose and first measures of urban sprawl were conducted. Small (2000) argues that the public and policymakers often use the term as a medical analogy. Urban sprawl is seen as a disease, detected by its undesirable symptoms. Many cures are offered for this disease, although we seem to be lacking a solid understanding of the underlying causes and mechanisms. Al Gore (cit. in Wassmer 2002) argues that sprawl has become the concept of the "enemy", without understanding exactly what it really is. As the concept of sprawl was "invented" in the US, it was anchored in the US context and discussion for a long time. Europe has the reputation of dense, multifunctional cites with mixed uses. The image of lively towns, with a strong historic background, is dominant. In recent years, however, the debate has spilled over to Europe. This is justified at least in part by the obvious development problems of many European cities, as the continent presents a very scattered puzzle of territorial conditions.

2.3 DEFINITIONS OF URBAN SPRAWL

Urban planning evolved throughout the twentieth century, leading to a great variety of urban forms which often had little regard for their impact upon the environment. In both developed and developing societies, this disregard is most evident in the rise of urban sprawl as the primary

form of urban development, one which has come under increased criticism in recent years because of its negative environmental, social and economic effects (Newman and Kenworthy, 1989; Hillman, 1996; de Roo and Miller, 2000; Jenks et. al., 1996; Breheny, 1992; Elkin et. al., 1991, in Duany et. al, 2000).

Siedentrop (2005) mentions five quite different types of definitions of sprawl:

1. Definitions of sprawl according to density attributes of a settlement system: these definitions consider low density forms of settlement, decreasing density und functional decomposition of cities as sprawl. Representatives of these definitions are for example Glaeser and Kahn, 2003, Fulton et al., 2001 in Siedentrop (2005).
2. Definitions of sprawl that deal with de-concentration processes of urban functions combined with the spatial expansion of urban uses into rural areas, represented by e.g. Glaeser et al. 2003, Pumain 2003 in Siedentrop (2005).
3. Definitions of sprawl characterized by structure and form attributes of a settlement system. Sprawl is understood as an urban form building process that transforms a former monocentric compact structure into a discontinuous, polycentric and disperse settlement structure (Galster et al. 2000, Torrens, Alberti 2000, in Siedentrop (2005).
4. Definitions based on socially relevant effects of land use, e.g. traffic induced effects, loss of fertile soils, etc. (Ewing, 1997, Downs, 1999).
5. Definitions based on normative planning and order perceptions. Unplanned urban development that runs counter to the objectives of spatial development is identified as sprawl Gassner 1978 et al. in Siedentrop (2005).

Galster 2001 understands sprawl as a condition of land use and states that general

approaches to sprawl can be by aesthetics, efficiency, equity, and environmental aspects. Furthermore, the author describes the following approaches to defining sprawl in more detail:

- Defining sprawl by an example: sprawl is often defined by one or more examples whereby Los Angeles is often seen as the prototype of sprawl: Robert Geddes (1997) in Duany et. al. (2000) calls it "fragmented, incomplete, ad hoc and uncentred."
- Defining sprawl by an aesthetic judgement: this normative approach describes sprawl as an ugly form of development. Representatives of this approach e.g. Clawson 1962 in Siedentrop (2005) used judgmental adjectives when talking about sprawl.
- Defining sprawl as the cause of an unwanted (negative) externality: definitions reach from judgments on the appearance of sprawl to alleged causal links between sprawl and its effects on land use patterns in the form of environmental, social and economic costs. These definitions are treating more the consequences than the attributes of sprawl (e.g. Downs 1998).

Urban sprawl may be defined as the scattering of new development on isolated tracts, separated from other areas by vacant land (Lata, et al. 2001). It has also been described as leapfrog development. Jothimani, 1977; Torrens and Albert, 2000 in Duany et. al, (2000).

European Environmental Agency, 2006 defines sprawl as the physical pattern of low-density expansion of urban areas, under market conditions, mainly into the surrounding agricultural areas. According to the same source, this results in a patchy, scattered, strung out, discontinuous and leapfrogged landscape.

However, urban sprawl is now viewed in a far more negative light in the planning literature, frequently implicated as causing excessive land consumption due to undervaluation of open

space, congestion due to increased commuting, and socioeconomic segregation due to exclusionary housing markets. Carruthers and Ulfarsson, 2002, in Duany et. al, (2000).. Furthermore, sprawl development is now perceived as contributing to significant fiscal costs for infrastructure providers such as local governments. Burchell and Mukherji, 2003 in (Duany et. al, 2000), and public health problems Sturm and Cohen, 2004; Kelly-Schwartz et. al., 2004; Nozzi, 2003 in Duany et. al, (2000).

The various definitions of urban sprawl in the planning literature have been summarized to create a working definition of the concept as: 'unplanned, uncontrolled, and uncoordinated single use development that does not provide for a functional mix of uses and is not functionally related to surrounding land uses and which variously appears as low-density, ribbon or strip, scattered, leapfrog, or isolated development. This low-density, single-use, automobile dependent type of development has come to dominate the urban environment in the past fifty years, and was brought about by a combination of regulatory, economic, social and cultural factors (Arbury, 2005).

2.4 CHARACTERISTICS OF SPRAWL

There are many characteristics that can be associated with the term urban sprawl although there remains debate in the planning literature with regards to the development of an exact definition for the term, and disagreement whether particular urban forms should be categorized as urban sprawl or not. According to Gillham (2002) there are four main characteristics of sprawl, which mirror the earlier definition given. These characteristics are leapfrog or scattered development, commercial strip development, low density, and large expanses of single-use development.

2.4.1 LOW DENSITY AND SINGLE USE DEVELOPMENT

The third, and perhaps most commonly recognized aspect of urban sprawl, is its low density. Gillham (2002) describes the density of urban sprawl as lying between that of the crowded urban core and open countryside, but being much lower than older towns and cities. Buildings in 'sprawl' developments are generally single-story, widely spaced and with intervening parking lots and roadways. Density is normally measured in terms of population density, or dwelling units per area. The mixed-use, higherdensity developments of early twentieth century cities, which facilitated both walking and the use of public transport, have been usurped by spatially dispersed cities and 'bedroom communities' of exclusive residential development, realistically accessible only by car.

2.4.2 LEAPFROG OR SCATTERED DEVELOPMENT

Leapfrog and scattered development go beyond the urban fringe to create built-up communities that are isolated from the city by areas of undeveloped land. In many ways these can be seen as the most extreme examples of urban sprawl, with a highly inefficient use of land, and a greater need to build highways and other infrastructure to service the outlying areas. Leapfrog development can be distinguished from 'satellite towns', a similar type of development beyond the urban fringe, by the former's much lower density and once again the almost exclusive reliance on the automobile as the method of transport for those living in such areas. The result is a haphazard patchwork, widely spread apart and seeming to consume far more land than contiguous developments (Gillham, 2002), and even though the open tracts of land are usually filled in eventually, leapfrog development remains an inefficient use of land.

2.4.3 COMMERCIAL STRIP DEVELOPMENT

Commercial strip development, another aspect of urban sprawl, is characterized by huge arterial roads lined with shopping centers, gas stations, fast food restaurants, drive-through banks, office complexes, parking lots and many large signs' (Gillham, 2002). 'Strip development' is very low density and automobile dependent, with retail configured in long, low boxes (portakabins/containers) or in small pavilions which are always surrounded by large parking lots. Trips between the different retail outlets are almost always made by car, due to the 'spread out' nature of the strip, and there is little if any emphasis placed on the needs of pedestrians.

2.5 CAUSES OF URBAN SPRAWL

The causes of urban growth are quite similar with those of sprawl. In most of the instances they cannot be discriminated since urban growth and sprawl are highly interlinked. However, it is important to realise that urban growth may be observed without the occurrence of sprawl, but sprawl must induce growth in urban area. Some of the causes, for example population growth, may result in coordinated compact growth or uncoordinated sprawled growth. Whether the growth is good or bad depends on its pattern, process, and consequences. There are also some of the causes that are especially responsible for sprawl; they cannot result in a compact neighbourhood. For example, country-living desire, some people prefer to live in the rural countryside; this tendency always results in sprawl. The causes and catalysts of sprawl discussed by several researchers can be summarised as presented in the following sections (for a general discussion one may refer Burchfield et al. 2006; Squires 2002; Harvey and Clark 1965).

2.5.1 Population Growth

The first and foremost reason of urban growth is increase in urban population. Rapid growth of urban areas is the result of two population growth factors: (1) natural increase in population, and (2) migration to urban areas. Natural population growth results from excess of births over deaths. Migration is defined as the long-term relocation of an individual, household or group to a new location outside the community of origin (Bhatta, 2010). In the recent time, the movement of people from rural to urban areas within the country (internal migration) is most significant. Although very insignificant comparing the movement of people within the country; international migration is also increasing. International migration includes labour migration, refugees and undocumented migrants. Both internal and international migrations contribute to urban growth. Internal migration is often explained in terms of either push factors—conditions in the place of origin which are perceived by migrants as detrimental to their wellbeing or economic security, and pull factors—the circumstances in new places that attract individuals to move there (Bhatta, 2010). Examples of push factors include high unemployment and political persecution; examples of pull factors include job opportunities or better living facilities. Typically, a pull factor initiates migration that can be sustained by push and other factors that facilitate or make possible the change. For example, a farmer in rural area whose land has become unproductive because of drought (push factor) may decide to move to a nearby city where he perceives more job opportunities and possibilities for a better lifestyle (pull factor). In general, cities are perceived as places where one could have a better life; because of better opportunities, higher salaries, better services, and better lifestyles. The perceived better conditions attract poor people from rural areas. People move into urban areas mainly to seek economic opportunities (Bhatta, 2010). In rural areas, often on small family farms, it is difficult to improve one's standard of living beyond

basic sustenance. Farm living is dependent on unpredictable environmental conditions, and during of drought, flood or pestilence, survival becomes extremely problematic. Other factors include a greater variety of entertainment (restaurants, movie theatres, theme parks, etc.) and a better quality of education. Due to high populations, urban areas can also have much more diverse social communities allowing others to find people like them.

These conditions are heightened during times of change from a pre-industrial society to an industrial one. At this transition time many new commercial enterprises are made possible, thus creating new jobs in cities. It is also a result of industrialisation that farms become more mechanised, putting many farm labourers out of work. Developing nations are currently passing through the process of industrialisation. As a result, growth rate of urban population is very high in these countries comparing industrialised countries.

2.5.2 Government Developmental Policies

Restrictive land-use policies in one political jurisdiction may lead development to 'jump' to one that is favourably disposed toward development or is less able to prevent or control it. Barnes et al. 2001 in (Bhatta, 2010). Often dissimilarities in development regulations, land-use policies, and urban services among the neighbouring municipalities (or local governments) may cause discontinuous development.

2.2.3 Lack of Proper Planning Policies

Lack of consistent and well-experimented planning policies may also cause urban sprawl. A city may be planned with exclusive zoning policies; this means separation of residential, commercial, industrial, office, institutional, or other land uses. Completely separate zoning created isolated

islands of each type of development. In most cases, the automobile had become a requirement for transportation between vast fields of residentially zoned housing and the separate commercial and office strips, creating issues of automobile dependency and more fossil fuel consumption and thereby pollution. A mixed land-use policy is preferred to fight against sprawl. (Bhatta, 2010).

2.2.4 Failure to Enforce Planning Policies

Having a proper planning policy is not enough, rather its successful implementation and enforcement is more important. Unsuccessful enforcement of land-use plans is one of the reasons of sprawl in developing countries, since the enforcement is often corrupt and intermittent in these countries. (Bhatta, 2010).

2.5.5 Economic factors

Land cover changes mostly result from individual and social responses to changing economic conditions, which are mediated by institutional factors. These driving forces are basically associated with issues of economy and social behavior. Burgi et al., 2004 in (Bhatta, 2010). It comprises factors that are related to level of economic development, individual preferences and socio-economic and political system that are basically related to human decision making process. Barredo et al, 2003 in (Bhatta, 2010). Opportunities and constraints for new land uses are created by markets and policies and are increasingly influenced by economic factors. Economic factors and policies define a range of variables that have a direct impact on the decision making by land managers, e.g., input and output prices, taxes, subsidies, production and transportation costs, capital flows and investments, credit access, trade, and technology. Internal consumption affects land less than external demand, so subsistence croplands consequently decrease while land under

crops for markets increases with a parallel increase in agricultural intensity. Improving agricultural technology as much as providing secure land tenure and giving farmers better access to credit and markets can potentially encourage more deforestation rather than relieving pressure on the forests. (Bhatta, 2010).

2.5.6 Demand of More Living Space

In many developing countries, residents of the core city lack sufficient living space. This encourages countryside development for more living space. People can buy more living space in the countryside than in the inner city, since the cost of property is less in the countryside. However, consumption of more living space not always causes sprawl. Population density is a major concern in this issue. Cities in developing countries are three times denser than the cities in developed countries. Acioly and Davidson 1996 in (Bhatta, 2010). Therefore, higher per capita consumption of built-up area (or living space) is desired in many instances. In such cases, higher per capita consumption of living space may indicate better and extended living facilities within the confines of compact urban growth. However, if the demand of more living space forces rapid low-density development in the countryside then it must be an indication of sprawl.

2.5.7 Living and Property Cost

Generally living cost and property cost is higher in the main city area than the countryside. This encourages countryside development. Harvey and Clark (1965) say ‘at the time of sprawl occurred, the cost was not prohibitive to the settler, (rather) it provided a housing opportunity economically satisfactory relative to other alternatives’. Generally majority of urban residents

seek to settle within the core city, but lower living and property cost attract them to the countryside.

2.5.8 Institutional factors

Formal and informal institutional arrangement influences directly or indirectly land use decision making. Land ownership and tenure are perhaps the most influential factors. In the case of individual land ownership, decision making is quite different from the case where land is under communal or state ownership. Other influential institutional factors include national, supranational and international environmental and resource policies and regulations (e.g. nature conservation, pollution control, etc.), spatial planning and development policies, etc. Equally important are economic, financial and social policies and institutions affecting the availability of capital, finance, labour, level of profit, etc (Arbury, 2005).

To explain land cover changes, it is also important to understand institutions (political, legal, economic, and traditional) and their interactions with individual decision making. Access to land, labour, capital, technology, and information is structured (and is frequently constrained) by local and national policies and institutions. Land managers have varying capabilities to participate in and to define these institutions. Many land cover changes are due to ill-defined policies and weak institutional enforcement, as exemplified by the widespread illegal logging in Indonesia linked to corruption and to the forest of forest management responsibilities to the district level. On the other hand, recovery or restoration of land is also possible with appropriate land use policies.

Examples of policies that influence land cover change are state policies to attain self-sufficiency in food, also urban land regional planning policies, which are policies that are related to zoning, which regulate urban space (locations) to be occupied by land cover type over space and time. These factors can be generally considered as constraints. According to Burgi et al. 2004 in

Bhatta (2005), zoning is a core driving factor in urban development process, for example introducing protection of forest land cover may affect the location of urban residential lands. . Informal institutions that influence land use decision, especially in developing countries are informal money lending institutions, informal labour market, family networks, etc.

2.6 IMPLICATIONS OF URBAN SPRAWL

According to OECD (2000), urban sprawl has a range of negative consequences. Frequently mentioned consequences are: green space consumption, high costs of infrastructure and energy, an increasing social segregation and land use functional division. Furthermore, the need to travel, dependence on the private car and as a consequence increased traffic congestion, energy consumption and polluting emissions are associated with sprawl.

Due to Wassmer (2005) a lot of negative urban consequences can be attributed to sprawl, but sprawl also has positive effects. When it comes to negative effects, the car and its polluting effects, a lack of functional open space, air and water pollution, a loss of farmland, tax dollars spent on duplicative infrastructure, concentrated poverty, racial and economic segregation, a lack of employment accessibility etc. Talking about positive effects of sprawl there have to be considered increased satisfaction of housing preferences, the convenience of car travel, the filling in of leapfrogging land, lower crime rates and better public schools in suburban local governments. Glaeser et al. (2003) analyse the impacts of sprawl in form of traffic congestion, environmental consequences, infrastructure costs and social consequences. They conclude that cars are producing externalities in form of congestion and pollution. However because of the decentralisation of jobs, the pollution problem is reduced. As people move to edge cites, commutes are getting shorter. Sprawl uses up formerly undeveloped land. But, on the other hand

only a small portion of (US) landscape is built- up land, implying that there is no scarcity of land. He further argues that externalities decreased over time per miles travelled. Moreover urban agglomeration economies may be reduced by sprawl and deter overall productivity. However, this must not necessarily be the case. Sprawl cities differ substantially in productive, as a simple comparison of e.g. Detroit and Silicon Valley shows. The only true negative consequences of sprawl are social. The segregation processes that have been discussed above lead to a sharp social separation: Those who can afford cars live in the suburbs, those who can't in the inner city.

Siedentrop (2005) takes a counter position and identifies the following impacts of sprawl:

1. Ecological impacts: Building and sealing of land, as well as indirectly loss of natural potential of soils and the expulsion of endangered animal and plants.

The problem is not that agricultural space is used, but the fact that connected agricultural land is destroyed.

2. Traffic impacts: It is argued that there is a negative correlation between built density and traffic costs. Inhabitants of densely built cites have to bear lower traffic costs. Efficiency of public transport is higher than in urban areas with lower density. However, critics say that density has little influence on traffic behaviour.

   Since households and firms suburbanize, radial commuting to the city centre is more and more replaced by cross-commuting within the urban area. With jobs nearby, transportation costs may actually be lower, even in a more decentralized structure. The time cost of commuting would have increased even more without suburbanization.

3. Social and health impacts: Sprawl leads to an erosion of functioning urban cores. This has not only social and infrastructural consequences but also impacts on innovation

capacity of regional economies in formless space, creative milieus may develop worse. Cervero et al. 1997 in Siedentrop (2005). There is a significant connection between broadening of settlements and concentration of poverty in city cores. The degree of social interaction in sprawled areas has decreased. Putnam 1994 in Siedentrop (2005). On the other hand suburbia is not urban in form, but can be in terms of functions. Critics argue that social heterogeneity and cultural diversity in suburbs is higher than alleged.

The Transportation Research Board (1998) defines consequences of sprawl in the form of costs. The report divides effects of sprawl into five types of costs: public and private capital and operating costs, transportation and travel costs, land/natural habit preservation, quality of life, and social issues. They further argue that empirical or quantitative data is available in more or less detail concerning these aspects. Benefits of sprawl are often ignored.

a) Socioeconomic Implications.

Land is one of three major factors of production in classical economics (along with labour and capital) and an essential input for housing and food production (Armstrong, 2004). Thus, land is the backbone of agricultural economies and it provides substantial economic and social benefits. Sprawl is necessary and essential for economic development and social progress.

Sprawl, however, does not come without costs. Conversion of farmland and forests to urban development reduces the amount of lands available for food and timber production. Soil erosion, salinization, desertification, and other soil degradations associated with intensive agriculture and deforestation reduce the quality of land resources and future agricultural productivity (Wu, 2010).

Urbanization presents many challenges for farmers on the urban fringe. Conflicts with nonfarm neighbours and vandalism, such as destruction of crops and damage to farm equipment, are

major concerns of farmers at the urban fringe (Armstrong, 2004). Neighbouring farmers often cooperate in production activities, including equipment sharing, land renting, custom work, and irrigation system development. These benefits will disappear when neighbouring farms are converted to development. Farmers may no longer be able to benefit from information sharing and formal and informal business relationships among neighbouring farms. Urbanization may also cause the "impermanence symptoms" (i.e., a lack of confidence in the stability and long run profitability of farming), leading to a reduction in investment in new technology or machinery, or idling of farmland (Amos & Musa, 2012).

- ✓ **Socioeconomic implications of urban sprawl**

- Conversion of farmland and forests to urban development reduces the amount of land available for food and timber production
- Soil erosion, salinization, desertification, and other soil degradations associated with agricultural production and deforestation reduce land quality and agricultural productivity
- Conversions of farmland and forests to urban development reduce the amount of open space and environmental amenities for local residents
- Urban development reduces the "critical mass" of farmland necessary for the economic survival of local agricultural economies
- Urban development patterns not only affect the lives of individuals, but also the ways in which society is organized
- Urban development has encroached upon some rural communities to such an extent that the community's identify has been lost

- Suburbanization intensifies income segregation and economic disparities among communities
- Excessive land use control, however, may hinder the function of market forces
- Land use regulations that aim at curbing land development will raise housing prices, making housing less affordable to middle– and low–income households
- Land use regulation must strike a balance between private property rights and the public interest

As urbanization intensifies, agricultural and non-agricultural land use conflicts become more severe. Competition for labour from non-agricultural sectors may raise farmers' labour costs. When the total amount of farmland falls below a critical mass, the local agricultural economy may collapse as all agricultural supporting sectors disappear.

Urbanization also presents important opportunities to farmers. The emergence of a new customer base provides farmers new opportunities for selling higher value crops. For example, Lopez, Adelaja, and Andrews (1988) found that vegetable producers tend to receive higher prices in urbanized areas. The explosion of nurseries, vegetable farms, vineyards, and other high value crop industries in many suburban areas illustrates how quickly agricultural economies can evolve. Many farmers have shown remarkable adaptability in adjusting their enterprises to take advantage of new economic opportunities at the urban fringe. They farm more intensively in areas with high population density (Armstrong, 2004). Urbanization has changed rural communities in many places. In some rural areas, urban sprawl has encroached to such an extent that the community itself has been lost.

Suburbanization brings urban and rural people and problems together. Most land areas are rural, most watersheds are in rural places, and most of the atmosphere exists above rural space. Urbanites and agencies have legitimate concerns about the use and condition of rural natural resources, just as rural populations have legitimate concerns about urban–based pressures on the natural world. These shared interests in the natural environment have important economic, social, and political implications, which may profoundly impact society in the future.

The socio-economic impacts of sprawl are equally significant and give rise to serious concerns at all spatial levels. The food security and the water scarcity issues may arise out of reductions in the area of agricultural land and decreases in available water supplies that result from soil erosion, land degradation, desertification, industrialization, urbanization, suburbanization, and above all, poor management of environmental resources. In all these instances, unsuitable uses of land play an important role. These issues concern the fundamental question of whether there is enough food to feed the growing population of the urban area and enough water to cover present and future demands of an increasingly industrializing and urbanizing area.

Human security and vulnerability is a collective term used to denote all those factors that may pose threats to human health, welfare and well-being in a given geographic area. A proposed measure is the "Index of Vulnerability" comprising 12 indicators – food import dependency ratio, water scarcity, energy imports as a percentage of consumption, access to safe water, expenditures on defence vs. health and education, indicator of human freedoms, urban population growth, child mortality, maternal mortality, income per capita, degree of democratization and fertility rates (Armstrong, 2004).

In sum, sprawl provides many economic and social benefits, but comes at a substantial economic cost to society. Land conservation is a critical element in achieving long term economic growth and sustainable development.

b) Environmental Implications

Sprawl is arguably the most general socioeconomic force driving changes and degradation of ecosystems. Deforestation, urban development, agriculture, and other human activities have substantially altered the Earth's landscape. Such disturbance of the land affects important ecosystem processes and services, which can have wide ranging and long term consequences.

According to Meyer and Turner (1996), sprawl causes a multitude of environmental impacts at urban areas which have been extensively documented. Especially important are the sprawl that occur in the periphery of large urban concentrations that are subject to urbanization and industrialization pressures and frequently result in losses of prime agricultural lands and tree cover. Their environmental impacts include changes in the hydrological balance of the area, increase in the risk of floods and landslides, air pollution, water pollution, etc. Other impacts of land cover change include soil erosion, sedimentation, soil and groundwater contamination and salinization, extinction of indigenous species, marine and aquatic pollution of local water bodies, coastal erosion and pollution.

- ✓ **Environmental Implications**
  - Land use and land management practices have a major impact on natural resources including water, soil, air, nutrients, plants, and animals
  - Runoff from agriculture is a leading source of water pollution both in inland and coastal waters

- Draining wetlands for crop production and irrigation water diversions has had a negative impact on many wildlife species
- Irrigated agriculture has changed the water cycle and caused groundwater levels to decline in many parts of the world
- Intensive farming and deforestation may cause soil erosion, salinization, desertification, and other soil degradations
- Deforestation adds to the greenhouse effect, destroys habitats that support biodiversity, affects the hydrological cycle and increases soil erosion, runoff, flooding and landslides.
- Urban development causes air pollution, water pollution, and urban runoff and flooding
- Habitat destruction, fragmentation, and alteration associated with urban development are a leading cause of biodiversity decline and species extinctions
- Urban development and intensive agriculture in coastal areas and further inland is a major threat to the health, productivity, and biodiversity of the marine environment throughout the world.

Concerning the costs of sprawl there are different debates in the literature: Ewing (1997) supports a compact city form with development through planning while Gordon and Richardson (1997b) are supporting the dispersed pattern of development with market led development. Another debate concerns the consumer preference for low density living: Gordon and Richardson (1997b) claim that consumers prefer to live in low density development, while Pendall (1999) claims that land use controls and fiscal arrangements can influence the density despite consumer preferences.

2.7 DEFINITION AND CHARACTERISTIC FEATURES OF URBAN SPRAWL IN NIGERIAN CITIES

Microsoft Encarta (2005), gives the definition of urban sprawl as the outward spread of built-up areas caused by their expansion. The expansion of the urban area is towards its country-side that surrounds it. The urban sprawl is believed to be one of the by-products of urbanization. Cities are generally regarded all over the world as providing the engines of economic development both for the cities themselves and their surrounding rural hinterland. UN-Habitat 2004 in Microsoft Encarta (2005). This is the major reason why cities are regarded as depots of opportunities for the urban dwellers to exploit for their economic and social development as well as magnetic poles that attract rural dwellers via rural-urban migration from their surrounding rural hinterland. Without any doubt, an urban centre (city) would only serve as engine of development if it is economically healthy, properly planned and managed in a way that would allow for efficient and functioning operations of infrastructural facilities among others. Otherwise, it can truly be drag on economic development. Ravallion (2001) in Microsoft Encarta (2005).

Due to uncontrolled urbanization, one major feature of Nigerian cities is urban sprawl. The urban sprawl is characterized by haphazard housing development in the urban suburbs, where majority of the structures are without planning permit in uncoordinated layouts. Often times, these structures are products of squatters that choose to settle at the suburbs as a result of their inability to afford residential accommodation in the city. The improper coordination of the physical development promotes high level of inaccessibility within the area. Such areas lacks essential social and welfare infrastructure like water, electricity, health care and educational facilities among others. The unsanitary conditions in the area poses continuous threat to healthy living of the inhabitants and it is an area regarded as area that is dangerously unsafe for living because of

its associated social vices. Above all, urban sprawl presents a repulsive outlook of the city space that calls for re-planning.

Unfortunately, there is no Nigerian city that can be exonerated from the stigmatization of urban sprawl. This has prompted Farunkanmi (2003), to draw the attention of town planners to the implications of sprawling city that if the governing authorities fail to inject the essential infrastructural facilities, such neglect would pose serious and dangerous implications for human health, progress and development. From the discussion so far, urban sprawl poses a lot of challenges to town planners, city managers, governments and stakeholders. It becomes expedient to identify the causes or factors responsible for urban sprawl in Nigerian cities.

2.7.1 FACTORS RESPONSIBLE FOR URBAN SPRAWL IN NIGERIAN CITIES

Different factors are responsible for urban sprawl in Nigerian cities. The unprecedented increase in the population in Nigerian cities continues to put pressure on the existing housing facility. The inability of the housing delivery to cope effectively with the housing need has succeeded in pricing out majority of the low income earners from the housing market. Most affected groups are the immigrants from the rural hinterland that prefer to settle at the suburbs of the cities. Often times, this is responsible for the development of squatter's settlement at the peri-urban zones (Olujimi and Gbadamosi, 2007)

Cities present unlimited socio-economic opportunities, particularly in areas of landed property development. The operations of the economic forces in the supply of land for commercial development within the city centres are encouraging the acquisition of land at the suburb of the city for residential property development. This has sufficiently propelled the greed for land speculation and hoarding at the suburbs. Unfortunately, most of the isolated parcels of land

hoarded at the suburb are not subjected to conventional design into layouts that could seek planning approval. Even when such parcels of land are designed into layouts, most of them are not properly charted to allow for coordination.

Hence, most of the layouts are not linked to others for accessibility purposes. Another factor that is responsible for the promotion of urban sprawl is the inability of government to effectively develop their compulsorily acquired parcels of land in some cities. This is predicated on the non-readiness of government to pay compensations on un-exhausted resources in the acquired land to the owners. Thus, the unwillingness of the owners to release fully the acquired land to government and their continuous disposal of the land to individuals, that continues to develop the land' without reference to the planning authorities to seek planning permission.

However, the planning authorities put in place are expected to control physical development in all parts of the city (including the sprawling areas) but the ineffectiveness of the development control tool at putting such sprawl at bay is hindered by a lot of factors. These among others include lack of political will to implement development control measures, insufficient planning staff to carryout effective monitoring, and lack of equipment such as development control monitoring vehicles. In spite of the shortcomings, efforts are being made at different quarters to check the sprawling growth of Nigerian cities.

2.7.2 EFFORTS MADE AT CHECKING URBAN SPRAWL IN NIGERIAN CITIES

United Nations Development Programme (UNDP) and United Nations Centre for Human Settlement (UNCHS) have subsequently initiated strategies to evolve a participatory approach to the development and management of urban environment hinged on the principle of sustainable development (Ogu, 2000). Popular among this is the Sustainable City Programme (SCP) which promotes a positive vision where all humans have adequate shelter, healthy and safe

environment, basic services and freely chosen employment. It also places strong emphasis on gender equality, partnership and good urban governance. In Nigeria, the

Sustainable City Project (SCP) was first applied in Ibadan, i.e. Sustainable Ibadan City Project (SICP) in 1992; and subsequently replicated in Kano and Enugu while the Sustainable Ibadan City Project had been abandoned due to nonreadiness of the major stakeholders (Oyo state government and the local government council authorities) to contribute their counterpart funding and the projects at Enugu and Kano have only started with skeletal ground works.

Ever before the introduction of Sustainable City Project in Nigeria, significant efforts had been made at redressing urban decay particularly at the core area in Nigerian cities in form of urban renewal programme but this was not extended to the urban sprawl at the peripheries of the Nigerian cities. This is because urban sprawl had not been seen as physical development problem that needs special focus except in form of preparing master plan for the existing settlement, a project that is believed to take care of the sprawling growth of the settlement in question. Besides the fact that not many cities and towns can boast of having master plan, the few cities and towns with master plan had become obsolete without any significant efforts to get them reviewed. Disappointedly, the few cities and towns with current master plan suffer the non-political will to implement/effect the development control measures that could check urban sprawl (Olujimi and Fashuyi, 2004). For instance, the Federal Capital Territory Abuja master plan, whose implementation is expected to make Abuja the pride of Nigeria, had suffered significant bastardizations pre-1999. Table 2 shows that most physical development that contravened the provisions in the master plan is from the private sector, which has 80 out of the 100 worst cases. It is interesting that government itself is not left out, having as much as 19 cases of contraventions while the remaining one was by an embassy.

The cases of contravention in Abuja as analyzed are not unique. They are features of the planning experience in other towns and cities in Nigeria, where growth is rapid and development control cannot cope with pressures of the development. Examples of these cities are Lagos, Enugu, Kaduna, Kano, Benin, Ibadan and Akure amongst others. However, the implementation of the Abuja master plan under the administration of the former president Olusegun Obasanjo (1999 – May 2007) controlled physical development in the city in spite of the political obstacles introduced by the previous administrations at *bastardizing* the master plan (Kalgo and Ayileka 2001; Olujimi and Ayeni 2006). Another effort at checking urban sprawl in Nigeria is the use of the provisions of the Nigerian Land Use Act of 1978. One of the objectives for the promulgation of the Nigerian Land Use Act in 1978 was to check urban sprawl and land speculation (Federal Government of Nigeria (FGN), 1978). The law amongst others gives power to the government at the three different levels (Federal, State and Local government) to compulsorily acquire land within their areas of jurisdiction for development in the overall interest of the people. The Act however, provides for the payment of compensation for the existing development on the acquired land and not for undeveloped land. The implementation of the Act continues to witness hindrance because of the failure on the part of the government for not recognizing the cultural rights of the land-owners. Even when land acquisitions are made by governments, their non-readiness to pay compensation to land-owners prompts owners of the land pronounced as acquisition to take-over and disposes such parcel of land illegally to individual developers. The developers now develop their land without any recourse to the Area Urban and Regional Planning Office yet the planning office feels unconcerned believing that they are illegal developments on government acquisitions. The non-readiness of the government to pay compensation cannot be attributed to non-availability of funds but to lack of interest at attaching

priority to such projects in terms of budgetary allocation and disbursement of funds. Rather than serving as check on the development of urban sprawl, the activities of the land-owners succeed in promoting urban sprawl. Under the State Urban Development Programme in 1985, each of the 36 State governments in Nigeria acquired and paid full compensation on the acquired parcels of land at different locations in their respective state capitals. The objectives of the programme amongst other is to improve institutional structures at the state and local levels and to strengthen urban management systems for the financing, delivery and maintenance of public services and infrastructure; and to improve the living conditions of the urban poor through the physical improvement (upgrading) of communities in greatest need and the development of serviced land for low-income groups (DHV Consulting Engineers, 1985). The acute housing shortage in all the state capitals prompted the State governments in Nigeria to embark on the sites and services project as a means to improve directly on the housing delivery but to check indirectly the problem of urban sprawl. Disappointedly, most of the locations selected for the project suffered low patronage due to the far distances of the project sites to the developed parts of the cities where the projects are sited (Onibokun, 1997). In spite of these efforts, cities in Nigeria are ridden with urban sprawl and this calls for people-oriented strategy at addressing the problem of urban sprawl.

2.8 STRATEGIES FOR THE CONTAINMENT OF SPRAWL

2.8.1 NEW URBANISM AND TRADITIONAL NEIGHBOURHOOD DEVELOPMENT

The term Traditional Neighbourhood Development (TND) has been utilized in planning and development circles within the City since November 2001 when the Flagstaff Area Regional Land Use and Transportation Plan was adopted. Indeed, the Regional Plan contains numerous

references to, and actively promotes the use of, Traditional Neighbourhood Developments. Incentives to promote TNDs are also provided in the Land Development.

New Urbanism emerged over the past two decades in response to the urban sprawl that has characterized development in most parts of America. From its earliest roots, the United States developed in the form of compact, mixed-use neighborhoods up to the first quarter of the last century. Urban development patterns began to change with the emergence of modern architecture and zoning and the expanded use of the automobile. Following World War II, neighborhoods were replaced with development patterns that separated land uses, i.e. conventional suburban development (CSD), or sprawl. New Urbanism is an approach to urban planning and design that can be applied at a variety of scales, moving from a single block in an urban area to a large metropolitan region. At the neighborhood level, New Urbanism is often referred to as Traditional Neighborhood Development because it revives the urban form and character of US cities and towns built from the 1600s until World War II.

2.8.2 SMART GROWTH

Many public health advocates have recommended smart growth as a potential solution to the problem of urban sprawl. Smart growth can be defined as a policy framework that promotes an urban development pattern characterized by high population density, walkable and bikeable neighborhoods, preserved green spaces, mixed use development (i.e., development projects that include both residential and commercial uses), available mass transit, and limited road construction. Smart growth was originally conceptualized as an aesthetically pleasing alternative to urban sprawl that would offer residents a high quality of life and the convenience of local amenities, but it also has many potential health benefits, such as diminished air pollution, fewer motor vehicle accidents, lower pedestrian mortality, and increased physical exercise. Smart

growth is different from the concept of “garden suburbs” because it addresses issues of population density and transportation, not just availability of green space and preservation of agricultural land.

In the 1970s, Portland, Oregon, was the first major city in the United States to establish smart growth urban planning by limiting urban growth to an area around the inner city. Since the 1990s, many other urban areas have encouraged the development of planned communities in which people can live, shop, work, go to school, worship, and recreate without having to travel great distances by automobile. An example of one of these planned communities is Southern Village, situated on 300 acres south of Chapel Hill, North Carolina. Launched in 1996, Southern Village features apartments, townhouses, single-family homes, and a conveniently located town center with a grocery store, restaurants, shops, a movie theater, a dry cleaner, common areas, offices, health care services, a farmer's market, a day-care center, an elementary school, and a church. Southern Village is a walkable community with sidewalks on both sides of the streets and a 1.3-mile greenway running through the middle of town. Southern Village residents have access to mass transit via Chapel Hill's bus system and can enjoy free outdoor concerts in the common areas. More than 3000 people live in Southern Village.

Urban sprawl has occurred largely because land owners and developers have made choices that promote their own economic and personal interests, which do not necessarily coincide with the public good. Many community leaders have found it necessary to engage in centralized urban planning to promote smart growth. Various laws and regulations can help to control land use and development. One of the most useful land use policy tools is to change zoning laws to promote mixed use development. Zoning laws that forbid commercial development in residential areas promote sprawl because they require residents to travel greater distances to buy groceries, shop

for clothes, and so on. Zoning laws can also be written to encourage high density development and to require sidewalks and bike lanes.

Another important policy tool for promoting smart growth is to take steps to prevent development outside of a defined urban area, such as forbidding new housing construction on rural land, or setting administrative boundaries for city services, such as water and sewer connections. The government can also use economic incentives to promote smart growth. Developers that follow smart growth principles can be deemed eligible for reduced fees that help offset the costs of smart growth development, such as environmental impact fees. Conversely, developers that do not follow smart growth principles can be subjected to higher fees. Finally, governments can also invest public funds in projects and land uses that facilitate smart growth, such as mass transit systems, recreation areas, and schools conveniently situated in neighborhoods.

2.8.3 THE COMPACT CITY

Much of the planning literature from 1990 onwards focuses on the compact city: a concept designed to implement sustainable development within the urban environment and to counteract the perceived negative social, economic and environmental impacts of urban sprawl. There have been many attempts to define exactly what a compact city is, '… but in general [it] is taken to mean a relatively high-density, mixed-use city, based on an efficient public transport system and dimensions that encourage walking and cycling' Burton cited in (Duany et, al., 2000). Through intensification of development within the city, many problems related to urban sprawl have the potential to be overcome, reversing the unsustainability of sprawl-type developments. Compact city policies have often been designed primarily to reduce the use of private cars and to minimise the loss of open countryside. However, proponents of the concept claim more than just

environmental benefits can be gained from intensifying urban areas; in fact 'higher density settlements are argued to be more socially sustainable because local facilities and services can be maintained, due to high population densities, and therefore accessibility to goods and services is more equitably distributed' (Williams, 1999: 168).

Furthermore, '…high density urban living is seen as a prerequisite for vitality, vibrancy, cultural activities and social interaction' (Williams, 1999: 168). The rejuvenation of local economies, particularly in downtown areas neglected by urban decentralisation and sprawl, can potentially also be achieved through intensification. Therefore, at least theoretically, it appeared that a solution to the sustainable city problem had indeed been discovered in planning literature by the mid 1990s, although with skepticism from some such as Breheny, Gordon and Richardson cited in (Duany et. al., 2000). Contention over exactly what a compact city is, and how a great variety of urban forms have been promoted as being 'compact' has proliferated throughout literature concerned with urban sustainability over the past fifteen years. According to Thomas and Cousins in (Duany et. al., 2000), initial impressions of the compact city

'…invoke an intense medieval city, whose limits are clearly visible, and where the hubbub of activity is confined within the city's walls'. While it is highly unlikely that urban planners advocate rebuilding walled cities, it is a confinement of urban activity that appears to be most desired by the supporters of the compact city theory. Indeed, Lock's (1995: 173) definition of a compact city as the process of ensuring '…that we make the fullest use of land that is already urbanised, before taking green fields'; or Naess' (1993: 309) definition of encouraging development to where 'technical encroachments on nature have already taken place' typify the approach of the compact city advocate. Cited in (Duany et. al., 2000)

However, although there may be consensus that the compact city is clearly distinct from urban sprawl, there still remain many questions surrounding exactly *how compact* the compact city should be, and to what extent it extends beyond a simple population density increase in the urban environment. Scoffham and Vale in (Duany et. al., 2000) argue that it is highly important to ask these questions about what the compact city is; whether buildings should be brought closer together; whether the number of people living in buildings should be increased; whether it is dwelling density or activity density that needs to be 'compacted'; and what role a mix of urban uses has in the compact city debate. According to Pratt and Larkham in (Duany et. al., 2000) 'One of the key problems with the compact city hypothesis is that it brings very diverse concepts together under a potentially misleading banner. Moreover, these concepts vary from polemics based on rather utopian ideologies through to minutely detailed empirical research.' Throughout the rest of this section, a detailed examination of the compact city literature will be undertaken in an attempt to answer some of the questions raised by Scoffham and Vale (1996), and to analyse whether the wide variety of concepts referred to by the 'compact city' hypothesis can be brought together into a sound theory.

Burton (2002) has identified that the task of measuring urban compactness involves three processes: firstly identifying and defining the various aspects of urban compactness; secondly developing indicators for measuring each of these aspects; and thirdly calculating and reviewing the measure of indicators for a range of towns and cities. The first process will be the focus of this section, although a range of density indicators will be compared on an international scale to understand how the compact city theory varies across European, North American, Australian and New Zealand cities. Generally three aspects of the compact city are identified: a high density city, a mixed-use city, and an intensified city (Burton, 2002). The first two aspects are related to

the form of the compact city, while the third focuses on the process of making the city more compact. This third point is critical because there are few opportunities for a compact city to be created from scratch, which in any case would appear highly contradictory given the aims of urban compaction. Thus, '…more compact cities can only be achieved through a process of making existing cities more dense, of encouraging more people to live in urban areas and of building at higher densities: of intensifying cities' (Williams et. al., 1996: 83).

Therefore, there is general agreement that the 'compact city model' is based around an increase in density from current levels. Given that a main goal of the compact city model is to reduce the impact of urban development upon the countryside, most future urban growth will need to occur within existing city boundaries (Williams, 1999). In an attempt to replicate the 'supposedly desirable' densely developed cores of old European cities, many different methods of intensification have been proposed, such as 'the development of previously undeveloped urban land; redevelopment at higher densities of existing buildings or previously developed sites; sub-division and conversions; as well as additions and extensions' (Williams, 1999: 168). However, the nature of this density increase, the role of

'mixed-use' development and the wide variety of international interpretations of the compact city concept are still contentious issues in the urban development literature. Lock (1995) claims that there is no technical or professional agreement on how best to measure density and that few planners are comfortable in distinguishing between net and gross residential density and overall town density. This disagreement makes it difficult to draw out the components of urban intensification and to identify what types of intensification should be encouraged, and what should be avoided. The nature of urban compaction has been deemed very important (Burton, 2002; Breheny, 1996) because certain types of development are generally thought of as being

more desirable than others high-rise apartment buildings are often associated with crime, overcrowding and the 'failure of tower-block living' (Williams, 1999; McLaren, 1992); while high-density that is not characterised by high-rise is often thought of as 'town-cramming' (Williams et. al., 1996). Measures of 'dwellings-per-hectare', 'habitable rooms per-hectare' or 'bed spaces per- hectare' have been used, especially in the UK, in an attempt to find an optimum density of development which is both more compact than current levels therefore helping to reduce the strain on the urban fringe for future development while also potentially creating other social and economic benefits attributed to the compact city model but its also low enough to find acceptance with the local population, who continue to express a preference for spacious low density living, McLaren cited in (Duany et. al., 2000). Ebenezer Howard's Garden City, considered to have a very low dwelling density at the time, was intended to be built at 180 bed spaces-per-hectare when it was first proposed (Burton, 2002). By comparison, in the inter-war years in Britain a standard of 120-150 bed spaces per hectare was adopted, and since the Second World War the density of new towns developed has been calculated at around 68 bed spaces per hectare (Burton, 2002). These figures appear to indicate that dwelling densities could be increased substantially before they would reach an undesirable level. Goodchild in (Duany et. al., 2000) confirms this argument through identifying surveys by the UK government suggesting that residential dissatisfaction only appears to increase when density levels exceed 200 bed spaces per hectare, while Rydin in (Duany et. al., 2000) argues that the optimum density for sustainable development is generally in the range of 150-180 bed spaces per hectare, well short of the 'above 200' danger zone, but higher than the 'below 100' zone of unsustainably dispersed suburbia. Therefore, it appears that substantial savings in land consumption can be made, through avoiding

the very low density development (of around fifty bed spaces-per-hectare) which characterises urban sprawl, without reaching density levels unacceptable to local residents.

2.9 SUSTAINABILITY AND SPRAWL

The term *sustainable,* in reference to human development patterns, first appears to have been used in the 1972 study of global resource use: *The Limits to Growth* Meadows et. al. cited in (Duany et. al., 2000). The authors of this work believed that the catastrophic collapse of global systems would occur midway through the twenty-first century if current growth rates and resource consumption continued, and that the only alternative was 'to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future' (Meadows et. al. 1972: 24). At the time, such thinking was quite radical as the 'environmental movement' had barely emerged. However, events around this time including the 1972 UN conference on the Human Environment and the 1973 oil crisis forced many academics and policy-makers to accept that current trends could not be maintained forever, and that drastic measures may be required to conserve natural resources for future generations. During the late 1980s and early 1990s sustainability became increasingly widely accepted; primarily due to the 1987 WCED report *Our Common Future* and the 1992 Earth Summit in Rio de Janeiro (WCED, 1987). The most commonly used definition of sustainable development, the recommendation of both the WCED report and the Earth Summit, is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' WCED in (Duany et. al., 2000). This definition recognises the importance of ensuring that the needs of the world's population *at the moment* should be met, with consideration for the needs of people in the future.

Therefore, the concept of sustainable development, which has formed the basis of environmental law in many countries around the world over the past fifteen years including

New Zealand is strongly related to the ethical norms of welfare, distribution, and democracy while recognising that nature's ability to absorb human-made encroachments and pollution is limited. Naess, cited in (Duany et. al., 2000). Haughton and Hunter in (Duany et. al., 2000) have identified three basic principles of sustainable development: the principle of inter-generational equity; the principle of social justice; and the principle of transfrontier responsibility. Each of these principles is seen as equally important in achieving sustainable development, especially when attempting to apply the concept in a situation such as designing more sustainable cities. The principle of intergenerational equity, or futurity, is what most people concentrate on when talking about sustainable development: the need to consider the effects on future generations' needs and aspirations when undertaking any human activity (Haughton and Hunter, 1994). However, equally important in the eyes of the Brundtland Commission was the principle of social justice, (also known as 'intra-generational equity'): that poverty needs to be tackled in present generations as it is a prime cause of environmental degradation. Sustainability, according to the generally accepted definition, means a more even distribution of resources, wider participation in environmental strategies and policies, and always taking into account basic needs and common aspirations. Finally, Haughton and Hunter (1994) refer to the principle of transfrontier responsibility, of a need for people to take stewardship of the global environment at a global level, which is necessary because many of the environmental problems (such as global warming) transcend national borders The principle also requires developed countries to refrain from the exploitation of resources in other areas, which can distort regional economies and ecosystems. However, there are major potential problems for those attempting to implement

sustainability throughout the world's cities, as the concept appears to conflict with urbanism at a fundamental level. Indeed, Elkin et. al, in (Duany et. al., 2000) stated that cities have never been sustainable, rather 'the process of urbanism in antiquity has been frequently linked with desertification in the hinterland. Cities have always exploited the surplus food and materials produced in the hinterland, and thus interfered with previously more cyclical ecological systems.' This fundamental conflict between sustainability and urbanism becomes clear when one analyses the environmental impact of urban areas. Cities house a concentration of polluters, from industry to cars, which contribute to the disruption of the earth's carbon cycle and could lead to global warming. Moreover, the vast food and energy use of the city, as discussed in the next paragraph, creates what has been termed an enormous 'ecological footprint', the amount of land needed to support the modern city (Naess, 2001). Furthermore, not only are today's cities unsustainable, but they are becoming more unsustainable all the time, as there is no doubt that the pre-industrial dense European city would have consumed far less than cities today which are characterised by urban sprawl.

Nevertheless, it is clear that while cities may be ever be able to actually achieve 'sustainability', they can become *more* 'sustainable'. Haughton and Hunter (1994) have calculated that on average each city of one million people consumes 625,000 tonnes of water, 2000 tonnes of food and 9500 tonnes of fuel, and generates 500,000 tonnes of waste water, 2000 tonnes of waste solids and 950 tonnes of air pollutants on a daily basis. While this level of resource consumption is clearly unsustainable, it remains very difficult to devise ways to reduce the levels of resource consumption while maintaining the high standard of living that people enjoy in developed nations. Although cities in the developing world are growing at a much faster rate than those in developed countries, the amount of resources used in these countries pales in comparison to the

unsustainable use of resources in every large developed world city. This means that increasing the sustainability of the world's developed cities must be a priority for policymakers, as there is both potential for great improvement and available resources to help implement necessary changes. Furthermore, as 'intra-generational equity' is a key element to Brundtland's definition of sustainability, it is important to analyse the wider impacts of urban sprawl on today's communities, as well as how these impacts are set to develop into the future.

Environmentally, there are two main concerns related to urban sprawl: the rate at which it is consuming the landscape and the air pollution that such a high level of automobile reliance is causing, Williams, 1999; Newman and Kenworthy, 1989; Guiliano and Narayan, 2003; Garcia and Riera, 2003; Anderson et. al., 1996; Kenworthy and Newman, 1990; Keyes, 1982; Owens, 1986 cited in (Duany et. al., 2000). As already mentioned, the great irony of urban sprawl is its attractiveness at the individual level, in particular the spacious sections and large houses of recent developments, but its destructiveness communally. According to Burchell and Mukherji in (Duany et. al., 2000), 742 out of the 3091 counties in the USA are affected by urban sprawl, and 13.1 million of the 23.5 million projected households for the period 2000 to 2025 will be constructed in areas characterised by sprawl. Therefore, at least in the USA (but also clearly in New Zealand), urban sprawl is a widespread problem affecting much of the urban development that has occurred in the past fifty years. This ubiquity means that any negative environmental impacts of sprawl are very significant, not just affecting a small proportion of the environment. It also means that the loss of land due to development is significant, with the American Farmland Trust believing that about 400,000 acres of prime farmland is being lost to sprawl each year in the USA alone (Gillham, 2002: 75). This also leads to the destruction of natural habitat for many species, which as a result have become endangered or are on the brink of becoming so, with

species such as the Pacific salmon and the Florida panther being seriously threatened (Gillham, 2002). Sprawl consumes land with particular ferocity, due to its highly inefficient form. This generally includes a surprisingly high percentage of land in sprawled urban areas being devoted to the needs of the automobile, with many American cities having close to half their land area occupied by either roads, highways, parking lots or other automotive-serving facilities (Duany et. al., 2000). This compares with about ten per cent of more compact cities being devoted to the automobile, which would lead to a far smaller loss of productive land (Duany et. al., 2000). Most tellingly, Mitchell (2001: 52) writes that: 'Seventy million Americans lived in the 13,000 square-miles comprising the nation's urbanised areas in 1950. Today about three times as many people live in a total metropolitan area that is more than fifty times as large.'

The link between sprawl and air pollution is also becoming increasingly significant, with a great amount of interest being focused on the issue of global warming, and measures to reduce levels of carbon emissions. Regulation has markedly improved air emissions from industrial areas in the past thirty years, leaving the greatest percentage of emissions these days coming from automobiles. Furthermore, although each individual car now emits far less than cars made before 1970, due to cleaner fuels and better tailpipe technologies, this improvement has been almost completely negated by the rapid increase in vehicle miles travelled (VMT) throughout the last 30 years. According to Southworth, 2001 in (Arbury 2005) 'between 1980 and 1999 aggregate US highway vehicle miles travelled is estimated to have increased by more than 76 per cent', an annual rate which far exceeds increases in population, jobs and disposable incomes. Southworth (2001) also identifies three main factors which have led to such a rapid increase in travel throughout the past 25 years: firstly, social and demographic growth and change within the population, which has led to increases in disposable incomes, the number of households and

vehicle-ownership levels; secondly, changes in the cost of travel, including declining (until very recently) real fuel prices, the use of more efficiently fuelled vehicles and faster travel times due to large highway investments; and thirdly, changes in land use and the associated built environment. This third factor is a specific reference to urban sprawl, which has radically changed the types, mix, density and spatial arrangements of land, altering both trip distance and frequency. As Southworth (2001) elucidates, 'the overall result is to create greater distances between what are often single use, segregated and often geographically extensive land developments. With connections between these parcels of developed land both necessitating and encouraged by the construction of intervening highway miles, the automobile has become the only economical form of travel between many places within a metropolitan area'. Although a growing body of research is concerned with this relationship between urban form and travel patterns, there remain many unanswered questions with regards to whether urban compaction can actually lead to a reduction in VMT. Much of the research of Banister, 1997; Cervero and Kockelman,1997; Ewing, 1995; Frank and Pivo, 1994; Meurs and Haaijer, 2001; Naess and Sandberg,1996; Newman and Kenworthy, 1989; and Stead, 1997 in (Arbury, 2005) does support the link between various aspects of land use and travel patterns or behaviour, although often only with respect to lower densities increasing VMT, rather than the opposite pattern. Indeed, even when travel costs increase through further decentralisation, increased traffic congestion or rising fuel prices, people are much more willing to adapt their travel patterns to suit where they want to live, rather than change where they live and what type of residence they have to suit their travel patterns. These issues will be discussed further when the compact city is critiqued, even though the relationship between sprawl and increased VMT does appear to be fairly universally accepted.

The environmental impacts of such a rapid increase in VMT are immense. 'The US Environmental Protection Agency indicated that in 1997, motor vehicles emitted over 50 million tons of carbon monoxide into the air, over seven million tons of nitrous oxides, over five million tons of volatile organic compounds, 320 tons of sulphur dioxide, and almost 15 million tons of road dust into the nation's air' (Nozzi, 2003: 2). Nozzi (2003: 2) goes on to state that: 'in 1991, air pollution from motor vehicles resulted in 50 to 70 million respiratory related restricted activity days, over 850 million headaches caused by carbon monoxide, 20,000 to 46,000 cases of chronic respiratory illnesses, 530 cases of cancer, and over 40,000 premature deaths.' Moreover, these costs are borne by the general public, in particular pedestrians and cyclists, rather than those doing the actual driving. Air pollution is also generally worst in the inner-city, because of the natural concentration of activity and therefore traffic, which once again is inconsistent with the source of the pollutants: most likely to be suburban commuters. Building more roads to reduce traffic congestion, which is commonly misconceived as polluting more than fast-moving traffic has no positive effect on pollution levels, with the most car-friendly cities in the USA such as Phoenix, Detroit, Denver and particularly Houston having toxic air emissions just as bad, if not worse, than most other cities (Nozzi, 2003). In 1998, Houston's toxic air emissions equalled 90 per cent of the total emitted by the whole state of California, while in 1999 its smog exceeded federal standards on 52 days (Nozzi, 2003). Reducing congestion has a far smaller effect on air quality than the number of vehicle trips and the length of those trips, and building more roads only encourages more car travel, therefore more air pollution. Nozzi (2003) concludes that urban dispersal is a major factor in causing air pollution, and that dispersed developments caused 20 to 50 per cent more air pollution than compact ones.

Economically, urban sprawl has been shown to be highly inefficient, especially in the provision of services and infrastructure by local governments. However, once again there is a strong mismatch between the individual economic effects of sprawl, and those on society.

Deal and Schunk, 2004 in Duany et. al. (2000) summarized this conflict by stating that: '…current low density sprawl development patterns are preferred because they are relatively cheaper for the developer and individual purchaser at the expense of the broader community and society as a whole.' Water and sewer infrastructure costs are one particular aspect of urban sprawl which can prove to be prohibitively expensive for local governments. Burchell and Mukherji (2003) state that under conventional (sprawl) development in the US between 2000 and 2025 there is a projected expenditure of about $190 billion in providing necessary water and sewerage infrastructure expansion to primarily single-family detached subdivisions. Although much of this investment would still need to occur under a more compact-type development, multifamily units require fewer laterals, fewer outdoor sprinklers and generally use less water than single family homes. Indeed, Burchell and Mukherji (2003) believe that roughly 150 million gallons of water and sewer demand per day could be saved through more compact development, without depriving users any of these fundamental facilities. Roading infrastructure is another area where significant cost savings could be made by focusing development in a more compact manner. 'Under conventional development, the US is projected to spend more than $927 billion during the period 2000-2025 to provide necessary road infrastructure, amounting to an additional two million lane-miles of local roads' (Burchell and Mukherji, 2003: 1537). While there would still need to be significant investment under a 'managed growth' policy, the difference over the time period could be around $110 billion, or an 11.8 per cent saving in local road costs. As well as basic infrastructure costs, sprawl is also economically inefficient with regards to the cost of

local public services. As development does not usually pay for itself, and required services include schools, hospitals and other government services, there is a significant cost to the public sector for urban development. Costs are generally lower in denser areas close to urban centres as economies of scale and absorption of existing excess capacity can reduce the need for expensive new developments (Burchell and Mukherji, 2003; Auckland Regional Growth Forum, 1999). Under conventional sprawl development, Burchell and Mukherji (2003) estimate that the US is expected to spend $143.2 billion annually on the provision of public services, of which only $99.4 billion would be recouped through the revenues from developments. This leaves a fiscal impact deficit of $43.8 billion annually in the provision of public services, a figure which could be improved by $4.2 billion if a more compact urban form existed. Furthermore, these costs are only the 'semi-direct' fiscal impacts of urban sprawl. Once more indirect costs, such as those relating to the economic impact of air pollution or traffic safety are taken into account; the costs of sprawl appear seemingly limitless. Nozzi (2003) estimates that in 1991 (but given in 1999 dollars) motor vehicle air pollution created up to $531 billion in health damage, $5 billion in crop damage, $44 billion in visibility damage, and $365 million in building damage.

Urban sprawl is also clearly economically unsustainable for many businesses, especially those located in central areas which have suffered from a 'dispersal of investment' towards the urban fringe. As their customers have moved away from the inner-city, businesses have begun to follow them as investing in older, decaying areas is simply a risk that not many investors are willing to take when the appealing urban fringe is open for development (Gow, 2000). Both the central city and the inner suburbs in many US cities are now seen as 'blighted', occupied only by those who cannot afford to move to the suburbs – a disenfranchised population riddled with crime and poverty (Deal and Schunk, 2004), and continuing the cycle of disinvestment in the

existing built-up areas. From an economic perspective, it is highly inefficient, wasteful and unsustainable to build new roads, schools, sewers, and waterlines at the urban fringe while leaving old ones in the inner city to deteriorate (Gillham, 2002). For many local governments, the plight of their inner-cities has been the most telling impact of urban sprawl, as these once bustling centres have been reduced to homogeneous parking lots and faceless office buildings, without street level retail activities, which are almost completely abandoned outside of office hours.

While the societal effects of urban sprawl are very difficult to measure accurately, they are also perhaps the most damning evidence of its unsustainability. Reduced social equity, negative health impact, a loss of community, segregation, polarisation and an inability to adapt to changing lifestyles and family structures are just some of the ways in which urban sprawl is said to adversely affect social sustainability (Gillham, 2002; Hillman, 1996; Deal and Schunk, 2004; Kelly-Schwartz et. al., 2004; Sturm and Cohen, 2004; Song and Knaap, 2004; Le Goix, 2005; Calthorpe, 1993; Nozzi, 2003, Duany et. al., 2000). Social equity is negatively impacted in many ways by sprawl: limiting transport options of the poor due to the high costs of car ownership and poor public transport; increasing the likelihood of poor people living in less desirable neighbourhoods; increasing fear and anxiety generated by high traffic volumes; greater exposure to air pollution and resulting poor health; and losing 'a sense of community' as most people travel beyond the local neighbourhood to conduct their daily activities (Hillman, 1996). In the most extreme form of urban sprawl, the 'gated community', there is complete social exclusion of 'undesirables' through the loss of public space, including streets. In many respects, the gated community is the culmination of processes that have created sprawl, as Le Goix (2005) describes them in Duany et. al. (2000) as '…a physical and obvious expression of the post-industrial

societal changes (fragmentation, individualism, loss of communities), as part of a commoditisation of urban public space, and as a penetration of ideologies of fear and security supported by economic and political factors.'

Gated communities are increasingly widespread; according to Blakely and Snyder (1997) in Duany et. al. (2000), there are approximately 20,000 such communities containing more than three million housing units. Furthermore, Blakely and Snyder estimate that eight out of every ten new urban projects are gated. Yet the problem with gated communities is not so much related to the gate, although the loss of public space is an important concern, but what the gate encloses. The exclusivity of gated communities creates a self-perpetuating segregationist pattern, with children who grow up in such communities being less likely to develop any sense of empathy with those living outside the gate, and perceiving them as *other,* with suspicion and contempt (Duany et. al., 2000). Indeed, 'the more homogeneous and "safe" the environment, the less understanding there is of all that is different, and the less concern for the world beyond the subdivision walls. It works both ways: the poor also have little understanding of the middle class, whom they consider to be in no way like themselves, and universally insensitive to their hardships (Duany et. al., 2000).

However, socioeconomic segregation extends well beyond gated communities in today's suburbanised cities. Housing clusters, or 'pods' often consist of houses entirely of a certain value, be it high, medium or low – even if they are not gated. Developers have encouraged this segregation according to housing-type by using the 'exclusivity' of the more expensive clusters to add value to their subdivisions. Maintaining the 'value' of the area becomes a primary concern for local residents, who will strongly oppose any plans to build more affordable housing in their neighbourhood because of the adverse effects it may have on the value of their property value

(Duany et. al., 2000). However, the homogeneity of the houses in a subdivision means that if someone's position in society changes, they may feel forced to relocate to a completely different community, abandoning neighbours, community groups, friends and schoolmates. More traditional neighbourhoods, in contrast to the suburbs of urban sprawl, included a wide range of housing types, which both encourage social equity through the interaction between people of different income levels in an informal, equal environment, and also allow people to move up or down in the housing market throughout their lives so they do not feel forced to relocate to another area. Furthermore, distributing affordable housing for the poor in a widespread fashion amongst more expensive houses, avoids the social problems associated with large tracts of inexpensive housing in many cities, both in the US and New Zealand, further entrenching crime and poverty. If the affordable housing is designed in a way that does not greatly distinguish it, and thus stigmatize it, from the surrounding residences, then there is likely to be little negative impact on the value of those properties.

While social impacts such as a 'loss of community' or 'a sense of exclusion' can be critiqued as being very vague, the health impacts of the 'sprawled society' clearly reveal a significant social cost, in addition to the economic costs already mentioned. The effect of automobiles, the overwhelmingly dominant mode of transportation when urban sprawl exists on health and well being, leads to some very sobering figures. As Nozzi (2003: 4) notes: 'The number of people who die on US highways every year is the equivalent of a fully loaded Boeing 747 aircraft crashing every three days, killing everyone aboard. In 2000, almost 6.5 million motor vehicle crashes killed 41,821 people and injured more than three million.' Due to these figures, motor vehicles accidents are the leading cause of death for people in the US of every age between four and 33. Furthermore, it is claimed that the physical structure of sprawl development, through its

greater reliance on the automobile as the primary method of transportation, discourages walking and other physical activities, therefore increasing the possibility of many physical ailments such as hypertension, heart disease and type-two diabetes Kelly-Schwartz et. al., 2004; Badland and Schofield, 2005) in (Arbury, 2005). Kelly-Schwartz et. al. (2004) sought to clarify this relationship between urban form and health impacts, specifically between different urban forms and levels of physical activity, and found that in general there was evidence to support the hypothesis that sprawl was related to health, but that the relationship was highly complex. Specifically, there was a fairly strong relationship between a highly accessible and gridded street network (a rarity in urban sprawl) and improved health levels, but a positive relationship also existed between low-density development (common to urban sprawl) and improved health levels. What the study does highlight is the importance of recognising urban sprawl as being much more than simply low density development. Thus, while higher-density living may have negative health impacts, those are likely to be the result of other aspects of the residence, such as being part of a segregated 'ghetto', being located next to a polluting highway, or through poor construction, rather than simply its high density. Similarly, just because an area is characterised by lowdensity development may not mean that is it 'sprawled'. Walkability, mixed-use developments and a reduced need for the automobile are arguably more important determinants of whether an area is 'sprawled' or not than its pure density. If sprawl is approached in this manner, it can be clearly seen that more compact traditional neighbourhoods are likely to lead to better health levels than ones dominated by urban sprawl.

Calthorpe (1993) in Duany et. al. (2000) takes a different approach to criticising urban sprawl compared with many of his colleagues. The incompatibility of sprawl and sustainability remains paramount, as he describes the automobile era as creating a situation where: '…the city and

suburb are now locked in a mutually negating evolution towards loss of community, human scale, and nature. In practical terms, these patterns of growth have created on one side congestion, pollution, isolation and on the other urban disinvestment and economic hardship' (Calthorpe, 1993: 9). However, what make Calthorpe's argument different is his belief that urban sprawl has 'had its day', and that the traditional suburban dream is becoming more and more incompatible with today's culture, because of changing household structures, family types, workplace environments and increasing environmental concerns. Despite these changes, 'we continue to build post-World War II suburbs as if families were large and had only one breadwinner, as if the jobs were all downtown, as if land and energy were endless, and as if another lane on the freeway would end traffic congestion' (Calthorpe, 1993: 15).

Increasing numbers of working mothers undermines the suburban lifestyle, as they are not available to chauffeur children for every trip that is required, or be at home when the children finish school. This breakdown of post-World War II society has led to concepts such as 'latch-key kids' and 'bedroom communities', which highlight the mismatch between our culture and our suburban landscape. According to Calthorpe (1993), widespread traffic congestion and unaffordable housing are two of the main indicators which show how urban sprawl is no longer compatible with today's society. An alternative model of growth, proposed by Calthorpe (1993), is based upon adapting the design principles of 'traditional' towns to the modern life style so that finely integrated walkable communities with a strong local identity and most of all a focus on the pedestrian rather than automobile can be created.

Through reducing reliance on the automobile, and mixing people of different incomes, social segregation and polarisation can be minimised to a much greater extent than is the case with an urban landscape dominated by sprawl.

The need for every family in the 'sprawled city' to own at least two automobiles means that buying a median-priced house is pushed beyond the reach of many. Duany et. al., (2000) state that in 1970, around fifty per cent of families could afford such a home, yet by 1990 this number had dropped to below 25 per cent, despite the rising number of households with two incomes. As housing becomes increasingly unaffordable, the segregation and polarisation of the urban landscape becomes increasingly severe: the growing number of people unable to afford reasonable housing become clustered in derelict ghettos rife with poverty and crime; while the rich themselves retreat behind the walls of their gated communities, perpetuating further segregation. The impact of automobile ownership on the purchasing power of prospective homeowners is surprisingly large: as Duany et. al. (2000) report that cars generally cost at least six thousand dollars a year, which they translate into more than sixty thousand dollars of purchasing power at conventional mortgage rates.

Therefore, for many families the need for two cars to fulfil their suburban lifestyle comes at the cost of owning their own home. Furthermore, those affected by a loss of homeownership are not the urban poor, but the middle-class with respectable jobs, creating what Duany et. al. (2002: 57) calls the 'middle-class housing crisis', further evidence of social polarisation.

As outlined above, the negative environmental, economic and social effects of urban sprawl are widespread, diverse and clearly at odds with the concept of sustainability. This is not particularly surprising, given Elkin et. al. (1991) assertion that urbanism fundamentally conflicts with sustainability. However, what is clear from the above analysis of urban sprawl is that improvements can be made with regard to the sustainability of our cities. Furthermore, improvements *need* to be made, especially in developed world cities, where on average citizens in North America (a highly urbanised society) consume sixteen times more energy than those in

Africa, and over eight times more than citizens in Asia or South America (far less urbanised societies) (Jenks et. al. 1996). To look at the situation more optimistically, developed world cities offer a tremendous opportunity to make significant sustainability gains, '…because that is where the most intense environmental damage is taking place, and it is there that many improvements can effectively be made' (White, 1994: 109). Jenks et. al., (1996: 4) expand on this, stating that 'with such a large proportion of the population, the concentration of environmental problems, and consumption of resources, cities clearly appear to be the most important location for action to help the goals of sustainable development'.

Therefore, achieving urban sustainability has been identified as a key part of any shift towards achieving sustainable development on a global scale. Due to this challenge, much of the planning literature throughout the 1990s has concentrated on the question of how to design the urban environment in a more sustainable way, and to look for alternatives to the ubiquitous sprawl that has dominated most urban development since the Second World War.

Firstly, there is the need to identify what urban outcomes can be said to contribute to sustainable development. In response to this need, Naess (2001: 506) has identified five elements of urban development and spatial planning deemed necessary for sustainable development to occur. They are:

1) A reduction of the energy use and emissions per capita in the city to a level compatible with the ecological and distributional criteria for sustainable development at the global level.

2) A minimizing of the conversion of and encroachments on natural areas, ecosystems and soil resources for food production,

3) A minimizing of the use of environmentally harmful construction materials;

4) A replacement of open-ended flows, where natural resources are transformed into waste, with closed loops relying to a greater extent on local resources and

5) A sound environment for the city's inhabitants, without pollution and noise damaging to the inhabitants' health, and with sufficient green areas to give opportunities for the population to experience and become emotionally related to nature.

Clearly, a fundamental shift in the form and function of the city will be required to meet any of these criteria for sustainability. Urban sprawl clearly conflicts with most, if not all, of the elements of sustainable development listed above. The UN's Agenda 21 and Habitat Agenda both suggest that the objectives of urban sustainability should include: 'a compact urban form; the preservation of open space and sensitive ecosystems; reduced automobile use; reduced waste and pollution; the creation of liveable and community-oriented human environments; decent, affordable, and appropriately located housing; improved social equity and opportunities for the least advantaged; and the development of a restorative local economy' (cited in Wheeler, 2000: 134).

However, the concept of sustainable development itself has been widely critiqued, and as will be shown below, many of the general critiques of sustainable development are also applicable to its application in the urban environment. Somewhat ironically, a very strong critique of sustainability is based on the notion that the concept is 'too' popular, and impossible to disagree with. According to Naess (2001: 504) '…a manifold range of strategies and projects are promoted with the claim that they are derived from the very concept of sustainable development. It has become practically impossible not to be a supporter of a sustainable development, so there is a clear danger that the concept will be watered out.' Moreover, the broad nature of

sustainability; there is heated debate surrounding the questions of what we hope to sustain and what is meant by development (Grant et. al., 1996) means that while there is widespread support for the idea, it is unclear how, if or when sustainability can or will be achieved. With all of this faith being placed in such a broad, difficult to define concept, it is no wonder that some people are skeptical about huge changes to their lives in the hope of improving 'sustainability'. Grant et. al., (1996: 333) summarise what those attempting to implement more sustainable practices confronted with, by stating that: 'Traditionally, many North Americans have defined success in terms of a big house on a big lot. Such cultural attitudes about landscapes, privacy, and leisure may inhibit the willingness to adopt sustainable practices that require social responsibility, and that entail significant spatial and behavioural changes. A sustainable society operates differently from the one we know now.' For sustainability to be successfully implemented in future urban developments, either these cultural attitudes will need to dramatically change (which appears unlikely in the near future), or developments will need to be carefully designed to be more environmentally, economically and socially sustainable, but at the same time appeal to consumers as attractive places to live. The compact city concept attempts to provide a more sustainable alternative style of urban development to sprawl.

2.10 METHODS OF ANALYSING SPRAWL PATTERN

The technical strategy usually used for sprawl analysis are been designed to be extendible to other regions if essential elements (e.g. moderate resolution satellite data) are available. This mostly involve various steps, the below sections describe the basic steps of the procedures;

2.10.1 Satellite Databases

All Landsat MSS, TM, ETM and ETM+ scenes covering a specific region of interest will be assembled initially as path/row sets for use in the land cover characterization and change analysis. The temporal coverage of the study area can be obtained come from various archives such as USGS, GLCF, Quick bird etc. archive. The use of cloud-free imagery is important, as cloud cover tend to affect the analysis.

2.10.2 Land Cover Change Analysis

The primary image analysis task of most studies is determining general land cover transformations over some specific period. The land cover data sets are also needed for the calculation of landscape metrics that provide measures of the changes in landscape configuration. To describe land cover change within an area, information regarding land cover classes and conversions between land cover classes is required.

After collection of all the relevant primary and secondary data, the next task such study is the analysis, remote sensing and spatial matrics techniques are mostly use to quantify land cover change processes and patterns. Remote sensing image classification is a relevant method that can provide information on the extent and rate of land cover change, whereas spatial metrics are computed based on the image classification results to quantify the pattern of change.

2.10.2.1 Remote Sensing Image Classification

Classification in remote sensing involves clustering the pixels of an image to a relatively small set of classes, such that pixels in the same class are having similar properties. The majority of image classification is based on the detection of the spectral response pattern of land cover

classes (Abebe , 2013). In order to utilize remote sensed image effectively, several image classification methods have been suggested and developed over the past decades. But there is no single ideal classification method for each and every remote sensing image. The choice of image classification method mostly depends on the objectives of the researcher, the nature of image and the level of detail or accuracy required for specific application (Lillesand et al, 2008).

There are two types of classification procedures: supervised classification and unsupervised classification. Supervised classification is the process of assigning objects of unknown identity to one or more known features using training data. Maximum likelihood (ML) classification algorithm assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class. Each pixel is assigned to the class that has the highest probability (i.e., the maximum likelihood). Better results can be achieved in supervised classification technique by taking more features and training samples from the study area. Training data are objects selected as representative samples of known features. In supervised classification prior knowledge of the ground cover is important to select training samples. The advantage of the ML classification algorithm is that it takes the variability of the classes into account by using the covariance matrix. However, its disadvantage arise from the time and effort required to prepare the training sample (Islam &Ahmad, 2011).

In unsupervised classification technique, an algorithm is chosen that will take a remotely sensed data set and find a pre-specified number of statistical clusters in multispectral or hyper-spectral space. Although these clusters are not always equivalent to actual classes of land cover, this method can be used without having prior knowledge of the ground cove in the study area (Muhammad et al, 2009). Contrary to the use of analyst-provided information in supervised classification; unsupervised is a clustering of the data space without any information provided

by the analyst. Analyst information is used only to attach information class (e.g. ground cover type) labels to the segments established by clustering. Clearly this is an advantage of the approach. However, the result of clustering is simply the identification of spectrally distinct classes in image data. These classes do not necessarily relate to the informational categories that are of interest to analyst. Hence, proper interpretation of these classes is required along with reference data that requires understanding of the concepts behind the classifier and familiarity with the area under analysis (Lillesand et al, 2008).

Maximum likelihood classifier is one of the most popular and widely used types of image classification technique in remote sensing (Abebe, 2013). Several researchers have demonstrated the importance of supervised maximum likelihood classification technique for land cover change analysis. For example, Tang et al. (2008) analysed the spatiotemporal landscape dynamics of two petroleum-based cities: Houston, Texas in USA and Daqiung in China. They used the MLC method to classify six multi-temporal satellite images. Zhou and Wang (2011) also used MLC to characterize the changing patterns and intensities of green space in Kunming, China from 1992 to 2009.

2.10.2.2 Accuracy Assessment

In remote sensing land cover analysis, classification accuracy is most important aspect to assess the reliability of the final output maps. The main purpose of assessment is to assure classification quality and user confidence on the product (Burgi et al., 2003). Randomly sampled ground truth points obtainable from field work or reference points obtainable from reference data are used in the assessment. Abebe, (2013) used 270 randomly sampled ground truth point obtained from

field work and from a previous work to quantify urban growth pattern using remote sensing and spatial metrics in Kampala, Uganda

2.10.2.3 Remote Sensing and Spatial Metrics

Remote sensing alone cannot provide full description of the underlying processes that are responsible for the changing pattern of urban landscape. To bridge this gap spatial metrics are used. Spatial metrics are suitable tool for quantifying spatial heterogeneity and to have better insight on how spatial structures impact the system interaction in a heterogeneous landscape. It can provide rich numerical description of the landscape structure at patch, patch class or the whole landscape level (Herold et al, 2003). There are several spatial metrics, few of which can be applicable to land cover change are as follows;

i. The Impervious Metric

This aims to measure land cover change by calculating the change in the amount of built surface, compares impervious change estimates derived from satellite imagery to population change data derived from census information. This approach is anchored on the assumption that land cover change is fundamentally defined as a relationship between population and the built-up environment. Human development typically converts native vegetation to impervious surfaces. A principal challenge to this method is the difficulty in measuring impervious surfaces using Remote Sensing Techniques. The method is also limited because it is not suitable for pattern analysis.

ii. Shannon's Entropy

Geographers study entropy levels in different population distributions and settlement patterns and use entropy-maximizing models to find the most probable pattern of spatial distribution in a

system which is subject to restrictions. In the analysis of land cover change, Entropy works on the principle that naturally occurring virgin land and landscapes are viewed as the normal and orderly state of things. Urbanization and human activity act to alter this naturally occurring state thereby creating disorder. A measure of this disorder is what the Shannon's Entropy represents. Shannon's entropy (Hn) can be used to measure the degree of spatial concentration and dispersion exhibited by a geographical variable (Tang et al, 2005: Thomas, (1981). This measure is based on the notion that landscape entropy or disorganisation increases with changing land cover. Urban land cover are viewed as interrupting and fragmenting previously homogenous rural landscapes, thereby increasing landscape disorganization. The dispersal of built-up areas from a city centre will lead to an increase in the entropy value.

iii. Markov Chain

The term "Markov chain" refers to the sequence of random variables such a process moves through, with the Markov property defining serial dependence only between adjacent periods (as in a "chain"). It can thus be used for describing systems that follow a chain of linked events, where what happens next depends only on the current state of the system. The changes of state of the system are called transitions, and the probabilities associated with various state changes are called transition probabilities. The process is characterized by a state space, a transition matrix describing the probabilities of particular transitions, and an initial state (or initial distribution) across the state space.

The underlying tenet of a 1st order Markov process is based on the probability that the system will be in a given state (land class) at some time t_2 is deduced from the knowledge of its state at time t_1. Therefore, the probability does not depend on the history of the system before time t_1. When a Markov process moves from one time step to the next, the transition from one state to

the next only depends on that given state and not on how the process has arrived in that state. Markov process considers discrete states in the form classes of land cover and transitions occurring at discrete times. Also, a transition from one state to another can be thought of in either time or space in which space assumes the role of a discrete event or an individual pixel.

A Markov process is formally described by the transition probability function $P(t|x,t_0)$ which represents the conditional probability that the state of the system will be at time *t*, given that at time t_0 ($< t$) the system is in state *x*. So the transition probability matrix describes the specific character of the system where the elements of the matrix are the individual transition probabilities of one state moving to another state after one time or space increment. Transition probabilities are calculated based on the frequency distribution of the observations. Given the assigned land cover classes, a frequency table is developed where a count is made of the transition from one state to another over the specified increment. For example, a count is made of the number of times that forest land cover changes to agriculture for the whole scene from one time period to the next or in space from one grid square to the next.

2.11 IMPORTANCE OF SPRAWL ANALYSIS

The approaches taken for the analysis of Urban Sprawl are determined critically by the analyst's objectives. The definitions and land cover classification systems used, the theoretical schemata adopted and the models employed all depend on what the user needs and what the analysis seeks to address; i.e. on its purpose. The significance of this analysis are briefly discussed below, which are grouped into six main categories: description, explanation, prediction, impact assessment, prescription and evaluation (Helen, 2010).

2.11.1 Description

Descriptive studies of land cover change are necessary in any analytical attempt as a first step towards more refined analyses. Description of land cover change documents changes from one class of land cover to another over a given time period and within a given spatial entity. Changes in both the qualitative as well as the quantitative characteristics of land cover are described, the level of detail conditioned by the spatial level of analysis and the availability of vital data. Descriptive studies of land cover change have provided the impetus for more thorough investigations of the "why" of these changes as well as for taking actions (policies) to reduce the negative impacts of the changes identified.

Description alone, however detailed and thorough it may be, is not enough to provide the basis for understanding the observed land cover changes or to guide policy and decision making towards effective ways to cope with the adverse implications of these changes. Explanatory analyses attempt to fill this gap.

2.11.2 Explanation

Explanation attempts to address the question of "why" these changes have occurred (or, are occurring) and to uncover the factors or forces that bring about these changes directly or indirectly, in the short or the longer run. The level of explanation offered by any study is a matter of the chosen spatial and temporal level of analysis. Macro-analyses necessarily refer to global changes and take into account global explanatory factors or determinants of land cover change. As the analysis moves towards lower spatial levels, explanation moves deeper into the social and psychological dynamics that underlie observed human behaviour and, consequently, land cover

change. Similarly, explanatory analyses over long time periods attempt to reveal the macro-forces that induce changes such as social, cultural and technological change. On the contrary, short-term explanatory analyses necessarily seek for more immediate factors affecting human behaviour that leads to land cover change although the influence of the larger macro-forces can be taken into account as conditioning the shorter-term phenomena. Explanatory studies employ more or less specific theoretical schemata that account for the main determinants of land cover change and their complex interrelationships.

2.11.3 Prediction

In addition to describing and explaining land cover change, an important purpose for conducting such analyses is to predict future changes in land cover. Predictions may be unconditional or conditional. Unconditional predictions, also called trend forecast, provide future images of the land cover patterns in an area that will exist if past trends continue into the future. Unconditional predictions may be mechanistic forecast of past land cover change or, if they are informed by theory, they may be more thorough projections of past trends in the determinants and the resulting land cover change into the future. Conditional predictions of land cover change produce alternative land cover futures of an area under hypothetical conditions or scenarios. Some analyses are conducted with the purpose of predicting land cover changes caused by climatic change or by changes in future population, food and other habits and so on. Conditional predictions, based usually on scenario analysis, are frequently used in the context of policy making on issues of global change (e.g. climate change, biodiversity loss, desertification, etc.). In both unconditional and conditional predictions, the critical issues are the spatial and temporal level of analysis.

2.11.4 Impact Assessment

The contemporary interest is not so much on land cover change itself as is on its various environmental and socio-economic impacts at all spatial levels. In addition, as policies are designed to address several of the environmental and socio-economic problems in which land cover change contributes in one way or the other, policy impact assessment has emerged as a significant scientific activity. The recent policy interest, specifically, is on the broader issue of sustainability of development as it is impacted by land cover change triggered by proposed or implemented policies. Land cover changes with adverse impacts; such as land degradation, desertification, depopulation, etc. contribute negatively to the achievement of long term sustainability as they reduce the natural, economic, human, and social capital available to future generations.

2.11.5 Prescription

In a normative perspective, the analysis of land cover change may seek to address the question of "what should be"; in other words, the purpose is to prescribe land use configurations that ensure the achievement of particular goals. Presently, these goals come under the broad search for "sustainable land use solutions". The purpose of this type of analysis is to indicate those patterns of land cover (and, consequently, to prescribe the necessary change from past patterns) which are associated with environmental preservation, economic prosperity and welfare and social equity.

2.11.6 Evaluation

Analysis of land cover change may be undertaken for evaluating either past, present or future (policy-driven) changes in patterns of land cover in terms of certain criteria such as environmental deterioration (or improvement), economic decline (or growth), or social impoverishment; or more generally, against the criterion of sustainability. The results of these evaluations may be used to suggest land use alternatives (i.e. changes over those on which the evaluation was based).

CHAPTER THREE

3.1 METHODOLOGY

The term methodology, in a broad perspective refers to the processes, principles and procedures by which a problem is approached to seek answers. Methodology comprises data collection, organization and interpretation. It applies as to how the research is being conducted.

In the course of this research, data to be collected are data for spatial analysis of the pattern of the study area and socio-economic data for implications of sprawl which will be analyzed to achieve the aim of this study.

3.1.1 Procedure for establishing Sprawl Pattern

Firstly, remotely sensed satellite images of varied resolutions was obtained from GLCF (Global land Cover facility) and United State Geological Survey (USGS), which covers the study area and its environs for four epochs. The four images used for the study are the Landsat Multispectral Scanner (MSS) of 1976 with 80 meters resolution, Landsat thematic mapper TM 1990 with 30 meters resolution, Landsat ETM+ image of 2000 with 30 meters resolution and Landsat (Combine) Operational Land Imager & Thematic Infrared Sensor (OLI & TIRS) of 2014 with 30 meters resolution. These four imageries of varied intervals were preprocessed using Edras Imagine for image correction and enhancement of poor quality images and enhancement of low resolution images, after this, the images were layer stacked (band composite) for easy classification.

Secondly, processing of the corrected and already enhanced satellite imageries was established using ArcGIS 10.1 by applying true colours and false colours to the already layer stacked imageries for easy classification of the imageries. The study area was then clipped/carved out

from the whole scene (path 189 row 52) of each imagery which developed land cover classes using Maximum Likelihood Classification. Each class was calculated at the end of the classification process to determine the total size of each land cover in hectares for subsequent analysis.

Thirdly, the result of the different land covers from each epoch was applied in GIS using Overlay analysis Module in which compared the land cover statistics that detected the percentage change, trend and rate of the study area between 1976 and 2014.

The result of the above analysis determined the pattern of urban sprawl in the study area.

3.1.2 Process for establishing the causes of sprawl

The causes of urban sprawl gathered from the literature (Siedentop, 2005) are explained by high demand for urban land for residential use, poor urban planning and management, institutional factor. Another cause of urban sprawl is the social segregation, but the major cause of it is rapid urban population growth.

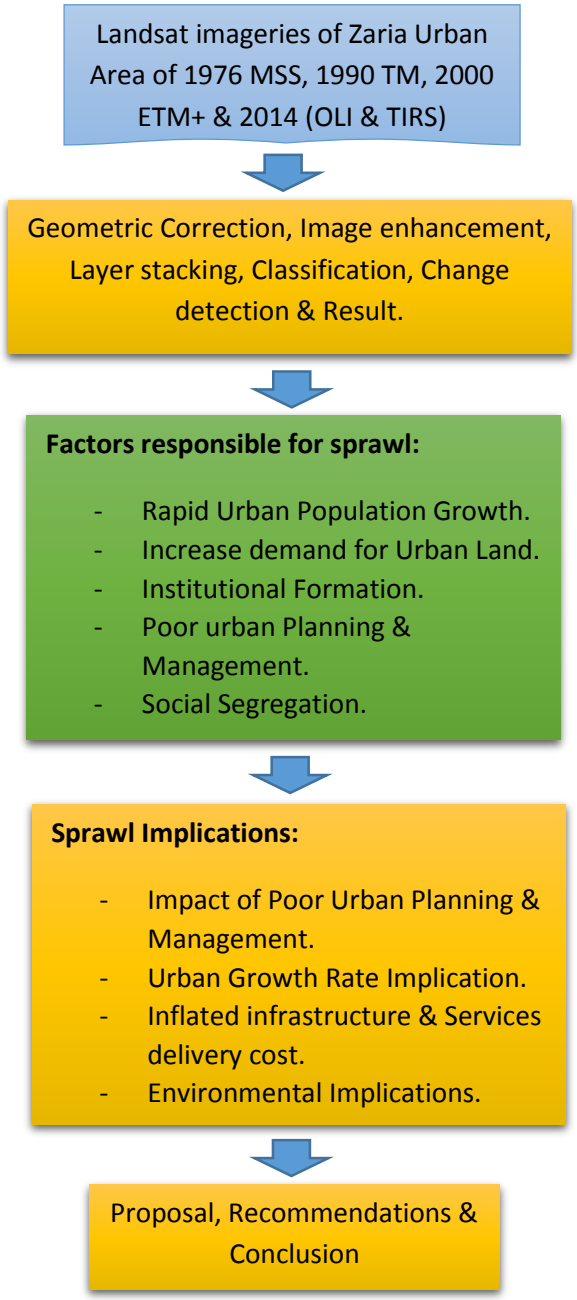
The process by which sprawl occurs as a result of poor urban planning and management is where people love to find areas that are less trafficked and less calm which leads them to sprawl out to other sections of the town. Unprecedented development, loss of green cover, poor infrastructure force people to move out to new areas. While citizens ignorance of urban legislation as a process of sprawl indicates that generally outside the main city is lesser controlled and loosely regulated. As a result, many developers and individuals find these places more suitable for new constructions.

Rapid population growth as a process that contributes to urban sprawl; as number of people in a city grows beyond capacity as a result of natural birth and urban migration which increase

subsequent expansion and urban development. And the inability of the local authorities to cope with the increases in population and solve problems arising from the regulatory bodies.

At this juncture, the implications are drawn from the sprawl pattern, after which physical planning proposal and recommendations are made base on the implications. A flow chart decribing the general methodology that was used in this study is given in figure 3.1.

Figure 3.1 Methodological Flow chart.



- **Data preprocessing**

The main data preprocessing operation to be used in this work is image enhancement. Image enhancement is the totality of operations to be performed on the image data to modify it; it is a useful way of improving its pictorial quality.

- **Development of a Classification Scheme**

Based on a priori knowledge of the study area for over 38 years and a brief reconnaissance survey with additional information from previous research in the study area, a classification scheme will be developed using a supervised method.

3.2 DATA REQUIRED AND SOURCES

There are two types of data required for this study; the primary and the secondary data. The primary data were sourced directly from the fieldwork of the study area. These data involves observation and reconnaissance survey. While secondary data required was the previous works of researchers with relevant information about my research. These secondary data involves satellite imageries, journals, articles and internet sites, published and unpublished thesis etc.

Table 3.1. Data required and collection methods

Data Type	Data Required	Data Source	Data Collection Method
Primary	- Knowledge of the study area.	- Field work.	- Reconnaissance survey.
Secondary	- Satellite imageries	- www.usgs.gov - Global Land Cover Facilities	- Using Path & Row of the study area to acquire the imageries.
	- Toposheet of Zaria Urban Area.	- Google earth & Suffer	- Acquiring coordinates of the study area using google earth then inputting them into suffer to generate the toposheet.
	- Administrative Boundary of Zaria urban area. - Legal & illegal layouts.	- KASUPDA	- Direct Interview.
	- Population data.	- National Population Commission.	- Document review.
	- Zaria master plan	U.R.P Dept, A.B.U Zaria.	- Document review.

Source: Author, 2015

3.3 DATA ANALYSIS OF SPRAWL PATTERN AND INSTRUMENTS TO BE USED

- EDRAS IMAGINE- this software was used in the research for the preprocessing of the imageries such as displaying them in the viewer interface, layer stacking (band composite) the imageries and image enhancement.
- ArcGIS 10.1 - This was used for the application of true colours and the false colours to layer stacked the imageries, it will also be used for the clipping (carving) out of Zaria urban area from the whole imageries scene in path 189 row 52 and development of land cover classes using Maximum Likelihood Classification in GIS and calculation of the

area in hectares of the resulting land cover types for each study year and subsequently compared the results.

- MAP OVERLAY ANALYSIS MODULE - This module was used for change detection analysis of the study area. The comparison of the land cover statistics assisted in identifying the percentage change, trend and rate of change between 1976 and 2014.

  Percentage change which determined the trend of change was then calculated by dividing observed change by sum of changes multiplied by 100.

$$\text{(Trend) percentage change} = \frac{\text{observed change}}{\text{Sum of change}} \times 100$$

- Microsoft word was used basically for the typing and presentation of the research.

CHAPTER FOUR

4.0 SPATIO-TEMPORAL ANALYSIS OF SPRAWL PATTERN, CAUSES AND IMPLICATIONS IN ZARIA URBAN AREA (2014).

In recent times, a lot of pressure in this field has been to understand and analyze urban sprawl pattern. The common approach is to consider the behavior of built-up area and population density over the spatial and temporal changes taking place and in most cases the pattern of such sprawls is identified by visual interpretation. However, in order to achieve sprawl pattern identification visually, the area under study has to be observed at different spatial and temporal scales. This is made possible by the availability of dated and recent satellite imagery at relatively good resolutions that enabled visual analysis and interpretation. In this chapter, satellite images at different temporal scales were used to facilitate a time series analysis of the spatial and historical change of Zaria urban area between 1976 and 2014.

The data for this this study was analyzed using classification, overlay analysis and descriptive statistical method, in the statistical method; mean and graphs were used to illustrate the changes of Zaria urban area in the four epochs.

4.1. ZARIA URBAN STRUCTURE/FORM IN FOUR EPOCHS.

After classifying the Landsat images for the four epochs (1976, 1990, 2000 and 2014) of Zaria urban area to establish the different forms of development which determines the **sprawl pattern** of the study area in 2014, the classified imageries formed the basis for the analysis of sprawl pattern to be carried out in this study area. Each map of a study year is made up of four different classes of land cover, which are classified into built-up, vegetation/green area, bare land surface and water body which have resulted in a simplified representation of the study area.

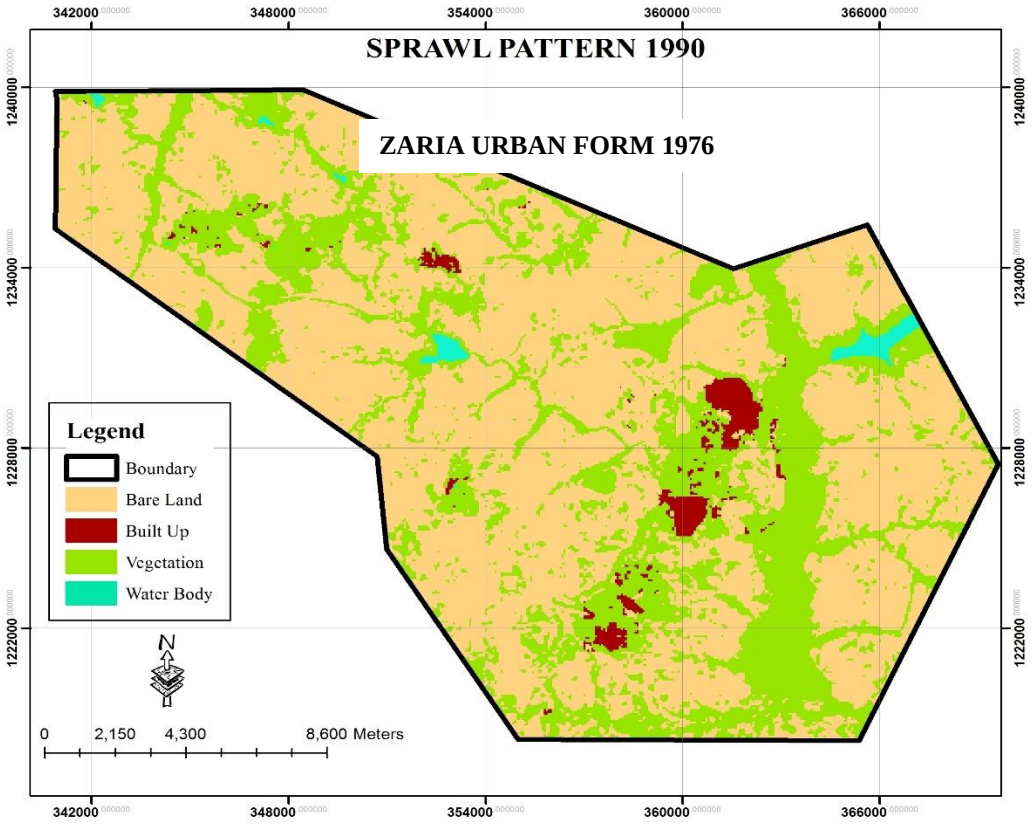
4.1.1 Zaria urban form 1976

From figure 4.1, the study area exhibited isolated or leap-frog pattern of development at this early stage of its development. This structure is attributed to the early history of the study area. These settlements were in existence by the transition period between the Stone Age and Iron Age such as Zaria city, Tudun-wada axis, Sabon-gari axis and Samaru with scattered patches of villages such as Panhauya, Anguwan Maigamo etc.

This growth in the population of settlements in the area as of this period seems to owe much to the development of Islam, where itinerant Muslim scholars and intellectuals who were also engaged in pastoral activities settled in Zaria city as their centre. The European area housing the government offices and residences for the colonial officers; the Tudun-Wada originally a labour camp meant for the natives of northern origin and Sabon-Gari which was designated for the southern natives that had come along with the British Military or migrated after wards. Later on, the railway stations as well as the industrial developments of Tobaco company in the area of Sabon-Gari axis were added to the urban landscape and Samaru axis originated due to the establishment of Ahmadu Bello University. These were all detached masses of development.

The total built-up in the study area in 1976 can be visually seen from the map in brown colour as relative isolated and dispersed development with 1203.99ha (3.3%) and population of 176,000 people according to the master plan.

Figure 4.1: Zaria Urban Form 1976



Source: Author, 2016

Table 4.1: Land cover distribution of Zaria Urban Area 1976

Year		1976
Land Cover	**Area (ha)**	**Area (%)**
Built-up	1203.99	3.3
Vegetation	10001.28	27.6
Water body	290.06	0.8
Bare land	24820.96	68.3
Total	**36316.29**	**100**

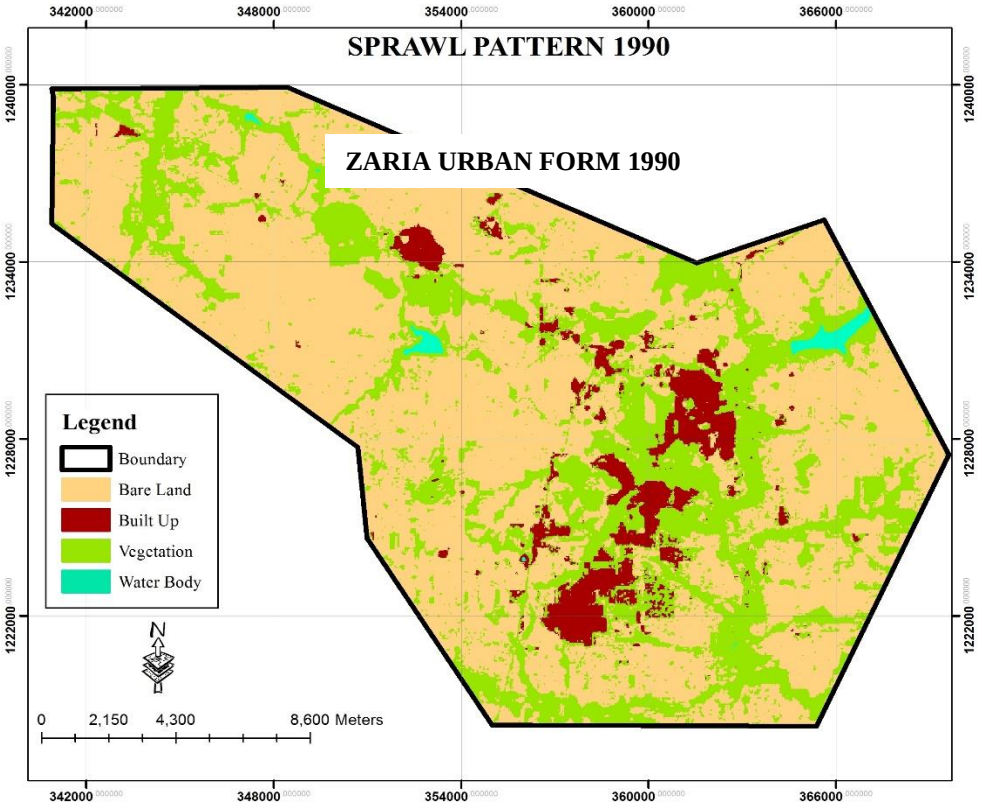
Source: Author, 2016

4.1.2 Zaria urban form 1990

This astronomical rise in population translated into accelerated and unprecedented urban expansion during this decade and the built fabric expanded to a much greater size in 1990 to (195.66 km^2) representing 10.5% than it was in 1976. However, the GIS analysis showed that between 1976 to 1990, development and growth continued to occur in addition to the existing development, the South- West (SW) of the study area such as Unguwan Dankali and Gwargwaje, North –East (NE) such as Chikaji and Jushin Waje , South-East (SE) e.g Kofar Gayan and Banzazzau and North- West (NW) such as Dogarawa and Hanwa respectively continued to expand from all angles of Zaria urban area.

This suggests that more settlements have emerged as an increase to the existing ones in the year 1976. Settlements such as Gaskiya, Gwargwaje, Unguwan Dankali, Tudun-Jukun, and Extension of Kusfa Low Cost to the South –West and Banzazzau, Jushi, Dembo, Dakace continued to expand to the South- East of Zaria urban area. While more settlements such as Muchia, Chikaji, Hayin –Ojo, Jushin Waje, Zabi and Shika Dam to the North –East, while Dogarawa, Hanwa low-cost, Unguwan Nashuka, Hayin Mallam, Zango, Hayin-Danyaro, Unguwan Gwaiba, Samaru New-Extension to the North-West axis. These increases are easily explained by the urban structure analysis on the built extent of Zaria urban area shown in figure 4.2 as derived from the classified satellite imagery.

Figure 4.2: Zaria Urban form 1990



Source: Author, 2016

Table 4.2: Land cover distribution of Zaria Urban Area 1990

Year		1990
Land Cover Classes	**Area (ha)**	**Area (%)**
Built-up	*3811.52*	*10.5*
Vegetation	9121.98	25.1
Water body	299.46	0.8
Bare land	23083.33	63.6
Total	**36316.29**	**100**

Source: Author, 2016

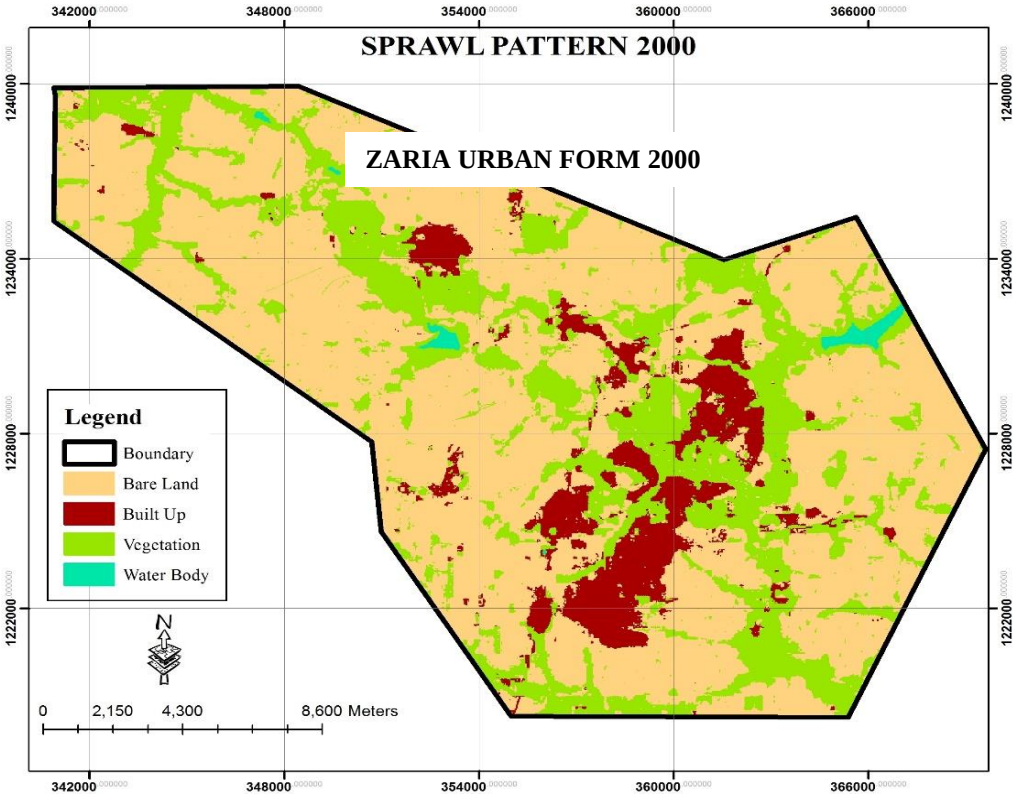
Most of this expansion was as a result of the different factors responsible for the emergence of the sprawl such as the higher Institutions within the urban area, Commercial activities Industrial activities, Transportation activities, Health etc.

4.1.3 Zaria urban form 2000

By the year 2000, the population of Zaria urban area increased by 36.17% changes from 500,424 persons to 650,582 persons (NPC 1991) Population projection. At this epoch, the built- up of the study area was approximately 224.17 km^2 (13.1%). The urban structure analysis of the built extent of Zaria urban area shown in figure 4.3 that most of the urban expansion in Zaria urban area during this period of ten (10) years was limited to infilling of spaces between the hitherto distinctly identifiable urban districts in both Northern and Southern sectors of the urban area forming ribbon or strip pattern of development. Some peripheral expansion however continued to occur as dispersed settlements.

In the South-East (SE) New Banzazzau, New Dakace, Nagoyi, New kusfa extension, Sabon-Unguwan kofar Gayan, Unguwan Kaya, Filin Mallawa, and Gaskiya Layout. To the North-East (NE) Unguwan Kanawa, Kwantaresha, New Hanwa GRA, Kabama layout, New Dogarawa, Grace Land and Unguwan Fulani. But to the North-West (NW) development continued in Hayin Liman, Unguwan Gwaiba, Unguwan Dakarkari and New Basawa Extension. While to the South-West (SW) some gradual expansion occured in Unguwan Saye, Madaci, Sayen Goburawa and Gwargwaje Extension. Most of these developments are along the major roads which results to ribbon or strip pattern development while others are infill developments.

Figure 4.3: Zaria Urban form 2000



Source: Author, 2016

Table 4.3: Land cover distribution of Zaria Urban Area 2000

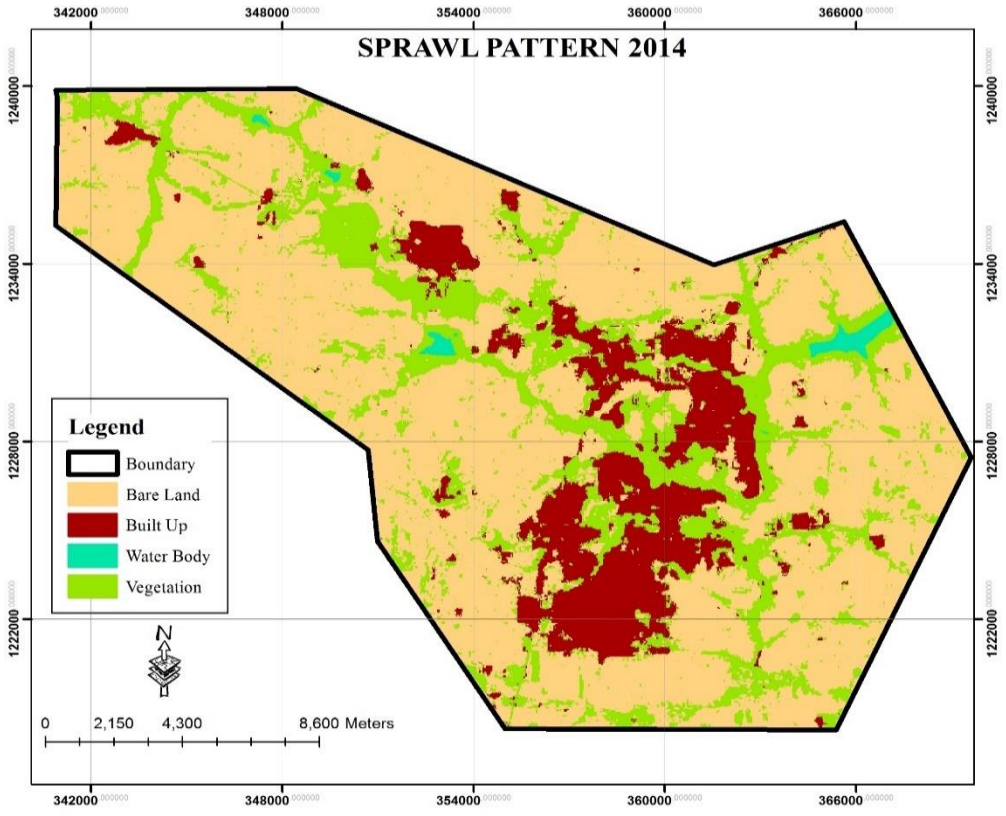
Year		2000
Land Cover Classes	**Area (ha)**	**Area (%)**
Built-up	4765.75	13.1
Vegetation	8738.95	24.1
Water body	294.91	0.8
Bare land	22516.66	62
Total	**36316.29**	**100**

Source: Author, 2016

4.1.4 Zaria Sprawl Pattern 2014

At this time, the total built-up in this epoch is 16.5% with projected population of 984,218 people, significant increases were recorded in terms of growth and development in a real expansion and built-up extent of the urban area. It can be seen in figure 4.4 that leap-frog and ribbon pattern of sprawl had fully developed North-South with the urban area spanning approximately 25 km on the North-South axis along Dogarawa - Gargwaje road, to the South-West along Gwargwaje - Kufena (Birnin Gwari road), to the North-West along Sabon gari – Samaru (Sokoto road) and Jos regional arterial road as compared to the 16 km on the East-West axis.

Figure 4.4: Sprawl Pattern of Zaria 2014



Source: Author, 2016

Table 4.4: Land cover distribution of Zaria Urban Area 2014

Year		2014
Land Cover Classes	**Area (ha)**	**Area (%)**
Built-up	*5986.34*	*16.5*
Vegetation	8371.43	23.1
Water body	304.81	0.8
Bare land	21653.72	60
Total	**36316.29**	**100**

Source: Author, 2016

This form suggests a continuous dispersal of development but at the same time infilling of the spaces between the scattered patches of development especially along the roads linking them. A further outwards expansion is also seen as isolated masses of development along almost all the major roads that link the urban area such as Zaria – Kaduna Express road, Zaria – Kano Express road, Zaria – Sokoto road, Zaria – Jos road and old Kaduna road (Saye).

4.3 COLLECTIVE ANALYSIS OF SPRAWL PATTERN IN ZARIA URBAN AREA (1976-2014)

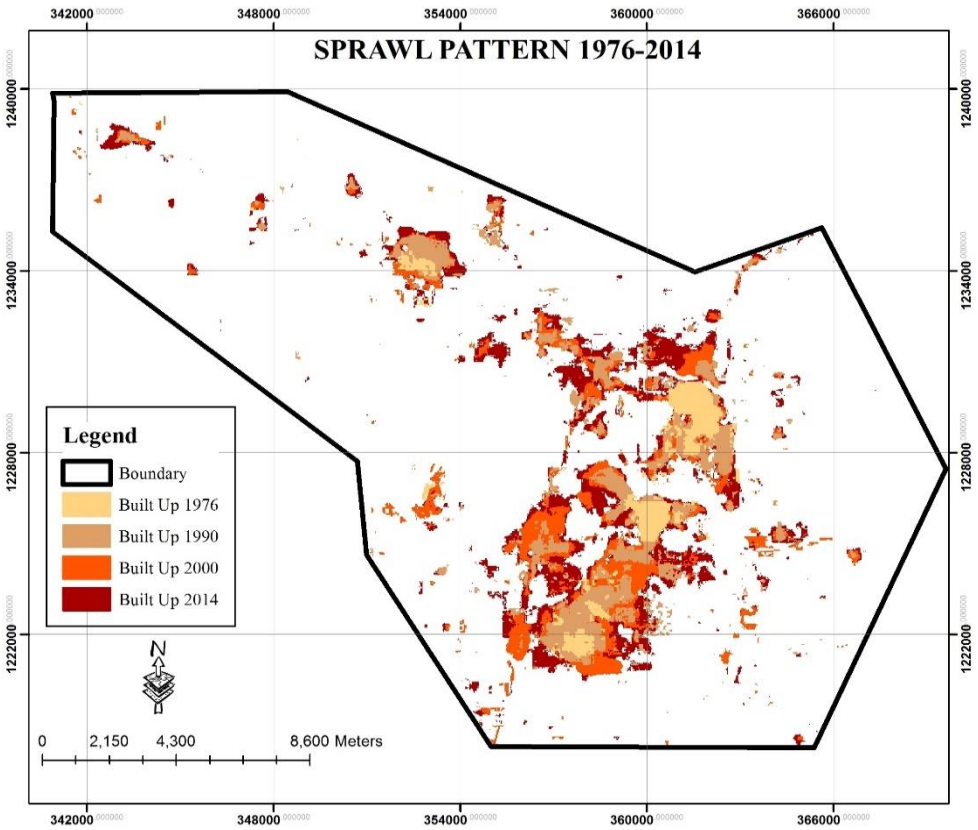
After carefully understanding the urban structure and character of Zaria urban area by examining the pattern of its component parts and the process of its development, this evolves the analysis of its spatial structure/form at different epochs as well as patterns of movement of the built-up fabric. The calculation of the proportion of sprawl pattern for the epochs from 1976 -2014 was performed using vector overlay and statistical analysis techniques. In order to have a clear understanding and a brilliant visualization of the overlay analysis, the four epochs were used and the analysis was done for the built-up fabric.

It can be seen in figure 4.5 that **ribbon pattern of development and leap-frog pattern** of sprawl had fully developed North-South with the urban area spanning approximately 25 km on

the North-South axis along Kano - Kaduna road, to the South-West along Gwargwaje - Kufena (Birnin Gwari road), to the North-West along Sabon gari – Samaru (Sokoto road) and Jos regional arterial road as compared to the 16 km on the East-West axis.

This form suggests a continuous dispersal of development but at the same time infilling of the spaces between the scattered patches of development especially along the roads linking them. A further outwards expansion is also seen as isolated masses of development along almost all the major roads that link the urban area such as Zaria – Kaduna Express road, Zaria – Kano Express road, Zaria – Sokoto road, Zaria – Jos road and old Kaduna road (Saye).

Figure 4.5: Pattern of sprawl between 1976-2014



Source: Author, 2016

Table 4.5: Proportion of Built-up change from 1976-2014

Year	Area (ha)	Area (%)
1976	1203.99ha	3.3%
1990	3811.52ha	10.5%
2000	4765.75ha	13.1%
2014	5986.34ha	16.5%
TOTAL	**15767.6ha**	**43.4%**

Source: Author, 2016

4.4 FACTORS RESPONSIBLE FOR URBAN SPRAWL IN ZARIA URBAN AREA

It is important to realize that urban growth may be observed without the occurrence of sprawl, but sprawl must induce growth in urban area.

The responsible factors of urban sprawl in Zaria urban area are as follows:

(a) Rapid urban population growth; the first and foremost responsible factor for urban sprawl is rapid/increase urban population. Rapid growth of urban areas is the result of two population growth factors: (1) Natural increase in population and (2) Migration to urban areas. Natural population growth results from excess birth rate over death rate while reason for migration could be explained in terms of either ***push factors*** i.e conditions in the place of origin which are perceived by migrants as detrimental to their well-being or economic security, and ***pull factors*** i.e the circumstances in new places that attracts individuals to move there.

Examples of push factors include high unemployment and political persecution and example of pull factors includes job opportunities or better living facilities.

People move into urban areas mainly to seek economic opportunities. From the analysis above, the expansion of the built-up area portrays that rapid urban population growth is one of the major factor of sprawl in the study area. In this regard, the influx of people and the increase in the birth rate in Zaria urban area due to polygamous marriage as well as

employment opportunities around are responsible. However, the people of Zaria originally live as homogenous and majority of them practice Islam as their religion, which gave them the right to marry up to four (4) wives. This is a reason why Zaria is booming every day.

In recent times, the rate of population has been astronomical due to high birth rate and migration. The population of Zaria urban area in 1976 was 176,000 people according to the master plan and the projected population to 2014 is 984,218 people. There was a great increase in the built-up fabric as of 2014 which causes sprawl.

Table 4.6: Trend analysis for rapid urban population between 1976-2014

Interval	Population Increase	Built-up increase (%)	Remarks
1976-1990	176,000-500,424	3.3%- 10.5%	The growth of Zaria urban area increased from 176,000 persons to a projected population of 500,424 persons within this period, which is attributed to the history of Zaria with small agricultural activities and with the increase activities within the main tertiary institution in samara and few others. E.g Poly, Industries around Chikaji.
1990-2000	500,424-650,582	10.5%-13.1%	At this period, population kept increasing at a low rate as a result of activities within other institutions such as F.C.E, Military deport etc.
2000-2014	650,582-984,218	13.1%-16.5%	Significant increase was recorded at this stage from 650,582 persons to 984,218 persons as projected is also as a continuous increase in economic activities of the study area which is a pull factor.

Source: Field Survey, 2016

(b) Increase demand for urban land; Just as in many developing cities, residents of the core urban areas lack sufficient urban land. This encourages sprawl development for more living space. As in the case of Zaria urban area, people buy more land in the outskirts along the four major roads that crosses through the study area than in the inner core city, since the cost of land is less in the outskirt. Therefore, higher per capita

consumption of built-up area is desired in many instances. In this case, higher per capita consumption of urban land in some parts of Zaria urban area indicates better and extended living facilities within the confines of compact urban growth. Eg Kabama layout, Bye-pass layout, Kauran Juli layout, Tukur-Tukur layout among others.

However, as the demand for more urban land forces rapid high (unapproved communities) and medium-density developments in the outskirt along the major roads such as Nagoyi, Anguwan Kaya, Filin Mallawa, New Dakace, Anguwan Saye etc, then it must be an indication of sprawl.

Increase in demand for urban land is another factor responsible for urban sprawl in Zaria urban area where the above analysis shows the rate and trend of built up expansion from 3.3% to 16.5% from 1976 to 2014 which led to loss of green area/vegetation. It is noted that the genesis for this increase in demand for urban land is from high population increase in the study area. For example, according to Micheal, 2012 there is a great depletion in agricultural land in the study area, in which from Zaria master plan agricultural land use was 13187.2 ha which has depleted to 6,663.2 ha by 2012.

Table 4.7: Trend analysis for increased demand for urban land between 1976 – 2014

Interval	Built-up	Increase	Built-up	Remarks

	(Ha)	increase (%)	
1976-1990	1203.99h- 3811.52h	3.3%- 10.5%	From the base year in 1976, Zaria urban area exhibited isolated or leap-frog pattern of development at the early stage of its development in which the built-up covers about 1203.99 hectares and rapidly increased to 3811.52 hectares by the year 1990. The astronomical rise in population translated into accelerated urban expansion during this decade.
1990-2000	3811.52h-4765.75h	10.5%-13.1%	There was limited increase in urban expansion during this period because most expansion in urban land was limited to infilling of spaces within the four districts in the study area forming strip pattern developments. Some peripheral expansion however continued to occur as dispersed settlements.
2000-2014	4765.75h-5986.34h	13.1%-16.5%	Significant increase was recorded at this period which is attributed to further outwards expansion along the major roads as a result of increased demand for land by the increased population.

Source: Field Survey, 2016

Table 4.8: Rate and Magnitude of Change

Interval	Built-up Increase (Ha)	Built-up increase (%)	Trend Percentage Change (Observed change/ Sum of change × 100)
1976-1990	2,607.53h	7.2%	54.52%
1990-2000	954.23h	2.6%	19.95%
2000-2014	1,220.59h	3.4%	25.53%
TOTAL	**4,782.35h**	**13.2%**	**100**

Source: Field Survey, 2016

(c) Institutional formation; Institutional formation causes migration to urban areas. Reason for migration could be explained in terms of either ***push factors*** i.e conditions in the place of origin which are perceived by migrants as detrimental to their well-being or economic security, and ***pull factors*** i.e the circumstances in new places that attracts individuals to move there. Examples of push factors include high unemployment and political persecution and example of pull factors includes job opportunities or better living facilities.

People move into urban areas mainly to seek economic opportunities. Therefore, the formation of several higher institutions of learning in the study area such as the Ahmadu Bello University, Zaria, Federal College of education, Zaria, ABU Teaching Hospital, Nigerian College of Aviation Technology, Zaria, Military deport, Nigerian Institute of Transport Technology, Zaria., Nuhu Bamalli Polytechnic, Zaria.,etc., happens to be one of the factors responsible for sprawl in Zaria urban area. This however, contributes immensely to the influx/migration of people into Zaria urban area to form a base for their living from 1976 to 2014.

Table 4.9: Institutions and sizes of Land occupied by them.

Institutions	Land Size (Ha)	Land Size (%)
Ahmadu Bello University (Samaru)	2,563.23ha	74.91%
Nigerian College of Aviation Technology	172.96ha	5.05%
CHELTECH	61.76ha	1.80%
Nigerian Institute of Transport Technology	87.99ha	2.57%
Federal College of Education	37.26ha	1.10%
Nuhu Bamalli Polytechnic	112.28ha	1.19%
Ahmadu Bello University (Kongo)	40.74ha	3.28%
National Research Institute of Chemical Technology	134.26ha	3.92%

Nigerian Deport	211.67ha	6.18%
TOTAL	3421.48ha	100%

Source: Author, 2016

(d) Poor Urban Planning and Management; having a proper planning policy in an urban area is not enough, rather its successful implementation and enforcement is more important. Unsuccessful enforcement of land use plans is one of the reasons of sprawl, since the enforcement is often corrupt and intermittent in our developing countries. Another important cause of sprawl is poor urban planning and management in which poor development control comes under the planning board in charge (KASUPDA).

In this case, poor consistency and well-experimented urban planning regulations causes urban sprawl. Generally, outside the main city is lesser controlled and loosely regulated, as a result, most developers find these places suitable for new development. Most sprawling activities takes place in Zaria urban area without adequate development control, urban management as a result of their negligence in most planning activities that springs up new Anguwanni (communities) which are not approved by Government.

Lack of proper management staff of the planning board also contributes to this factor in terms of inadequacy of technical staff and registered ton planners that are conversant with the rules, regulations and standards of town planning in KASUPDA. Other contributing agents to this factor is lack of facilities to carry out their duties, lack of monitoring, one Zonal office in charge of 6 Local Government Areas affects the labour force of the board.

Table 4.10: Approved Layouts and Unapproved Developments within Zaria Urban Area.

Approved Layouts	Unapproved Developments	Remarks
• Kabama layout • Zangon Shanu layout • Federal layout (beside CERT) • Gaskiya layout • Tukur-tukur layout • Bye-pass layout • Kauran Juli layout	• Nagoyi • Grace Land • Anguwan Kaya • Filin Mallawa • New Dakace • Dogarawa • Madaci • Anguwan Ganye • Anguwan Kanawa • Anguwan Dankali • Hayin Ojo • Hayin Malam • Hayin Danyaro • Anguwan Saye • Pampon Gwaiba • Buzai • Dembo • Gangaren Kwadi etc.	Due to poor planning and lack of monitoring, so many developments springs up where majority of the structures are without planning permit in uncoordinated layouts. However, KASUPDA is expected to control physical development in all parts of Zaria, but the ineffectiveness of the development control tool at putting such sprawl at bay is hindered by a lot of factors. These among others include lack of political will to implement development control measures, insufficient planning staff to carryout effective monitoring, and lack of equipment such as development control monitoring vehicles.

Source: KASUPDA, 2016

Table 4.11: Approved layouts and Unapproved Developments and their Sizes.

Approved Layouts	Land Size (Ha)	%	Unapproved Developments	Land Size (Ha)	%
Kabama Layout	85.36ha	31.63%	Nagoyi	35.01ha	3.88%
Zangon Shanu	29.37ha	10.88%	Filin Mallawa	41.32ha	4.58%
Fed. Layout (Beside CERT)	17.60ha	6.52%	Anguwan Kaya	23.17ha	2.57%
Gaskiya Layout	50.20ha	18.60%	New Dakace	33.83ha	3.75%
Tukur-Tukur Layout	41.73ha	15.46%	Anguwan Dankali	46.62ha	5.17%
Bye-Pass Layout	16.68ha	6.18%	Pampon Gwaiba	35.41ha	3.92%
Kauran Juli Layout	28.92ha	10.73%	Buzai	51.35ha	5.69%
			Dembo	45.34ha	5.03%
			Gangaren Kwadi	23.46ha	2.60%
			Dogarawa	105.28ha	11.68%
			Grace Land	191.91ha	21.29%
			Anguwan Ganye	30.53ha	3.48%
			Madaci	89.95ha	9.98%
			Anguwan Saye	26.11ha	2.89%
			Hayin Danyaro	11.26ha	1.24%
			Hayin Malam	27.58ha	3.06%
			Hayin Ojo	40.70ha	4.51%
			Anguwan Kanawa	42.22ha	4.68%
TOTAL	**269.86ha**	**100%**	**TOTAL**	**901.05ha**	**100%**

Source: Author, 2016

(e) Social segregation; social segregation process as sprawl in some parts of Zaria urban area where high classes of households acquire land at the new expansion areas and linear development layouts while the elite prefer to reside at the GRA's and new government layouts where crime is low and mingle with their class within the study area also contributed to the growth and sprawl pattern of Zaria urban area. The loss of high and

medium income population led to higher crime rates in most sprawled areas within the study area, low-performing public schools etc.

4.5 SUMMARY OF FINDINGS

The findings of this study revealed that Zaria urban area before 1976 was a typical rural settlement. However, Zaria is experiencing rapid influx of people which resulted to increase in urban land use, spatial expansion from 123.72 Sqkm in 1976 to 195.66 sqkm in 1990, while the population increase within this period of only 170,000 persons to 500,424 persons in 1990 according to 1991 census figures. Zaria experience more growth both in population and built-up area since before 1990, all as a result of the establishment of Tertiary Institutions within the urban area. Such as the establishment of Ahmadu Bello University, (A.B.U) Zaria, Nigerian College of Aviation Technology (NCAT), Nuhu Bamalli Polytechnic Zaria, Nigeria Institute of Transport Technology (NITT), Federal College of Education (F.C.E) Zaria etc.

The sprawl pattern commonly occurred in the study area is the linear or ribbon pattern, leapfrog or scattered development pattern of sprawl. The spatial dimension of Zaria urban area increase the travelling distance as proximity to place of work determines the people's choice of place of residence, as some travelled over 10km to their place of work. The result of urban area overlay analysis revealed that the major sprawl pattern occur along the major roads to Kaduna, Jos, Zaria-Sokoto road, along Dogarawa Kano road.

These four major roads that cross Zaria from all the four cardinal direction became the major growth poles. Zaria ribbon and leapfrog pattern of development structural growth process already engulfed so many settlement within and around Zaria urban area from 1976 to 2014. Which include: Banzazzau, Jushi, Dembo, New Dakace, Nagoyi, etc around Zaria wall axis,

Pampon Gwaiba, Gangaren kwadi, U/kaya, Filin Mallawa,etc around T/Wada axis, Chikaji, Shika Dam, Zabi, Jushin Waje, U/kanawa,Kwantaresha etc around Sabon-gari axis, Dogarawa, Hanwa low cost, Palladan, Grace land etc around Kwangila axis, Zangon shanu, H/danyaro, U/gwaiba, H/mallam, U/dakarkari, Samaru New Extension,etc around Samaru axis, U/dankali, Gwargwaje, U/saye, Sayen gobirawa etc around Dan-magaji axis.

Within the period under study, Zaria urban area experienced substantial growth in Socio-economic functions, the growth almost touches all the sectors of the economy, include education, commerce, recreation, transportation, health, infrastructural development, etc. As the third world urban centers growth cannot be disassociated with environmental and socio-economic problems, the problem of Zaria urban area are more visible in organic traditional settlement, as most of the people residing in the sprawl areas outskirt the old Zaria wall are mainly high and medium income civil servants. This study identified some urban management implications ranging from impact of poor urban planning and management, urban growth rate implication for Zaria urban area, Inflated infrastructure and service delivery costs, Environmental implications etc.

4.6 URBAN MANAGEMENT IMPLICATIONS OF SPRAWL

Consequences of sprawl may have both positive and negative implications; however, negative implications are generally more highlighted because this sprawl is often uncontrolled or uncoordinated and therefore the negative implications override the positive sides. Positive implications of urban sprawl include housing for the poor urbanites, opportunities for the underemployed and unemployed. The negative implications are discussed as follows:

a. **Impact of Poor Urban Planning and Management:** Field survey reveals that the roads reserves are converted to commercial layouts, in contrary to provision of developmental

plan and layout plan. The access roads in most of the sprawl areas are not up to standard as observation has shown that the sizes of access roads in some traditional wards are even more standard and larger than that of some new expansions/ layouts within the study area.

From the statistics above, it shows that layouts/communities that are unapproved by Government expanded more than twice the number of the approved layouts under approved and gazette development plans. This threatens danger for current land administration and management. If land is to play its role as a veritable asset and commercial commodity that can be used as security and collateral for loans and mortgages, then its management and administration must inspire the requisite confidence.

b. **Urban Growth Rate Implication for Zaria Urban Area:** Computing the rate of urban growth for Zaria was also achieved in this study by employing the mapping, measure area and map calculator modules in GIS to compute the area statistics of the built extent of Zaria Urban Area for the four epochs. The difference in area of the built extent between one epoch and the preceding one was computed and from the statistics, it was possible to estimate the growth rate for Zaria urban area put at a substantial 87.16h ($0.87km^2$) annually. This excessive physical growth rate is most likely to result in further sprawling with all its associated implications as there is no reason to suggest that growth will be in any other form or pattern. Furthermore, if the current rates of population increase and physical expansion are unrelenting, Zaria Urban Area is likely to double its size in spatial extent in the next 80 years.

c. **Inflated Infrastructure and Service Delivery Costs:** Residents of the sprawled areas are faced by an enormously costly delivery of urban infrastructure and services. 95% of

the sprawled areas are experiencing increase in demand for public infrastructure and services such as schools, pipe borne water, electricity, transformers, fire-service stations, police stations, hospitals, roads, drainages and refuse collection points and dumps as well as the maintenance and improvement. These expansions require more infrastructures, since it takes more roads, pipes, cables and wires to service these areas compared to more compact developments with the same number of households. As long as developers are responsible for the full costs of neighbourhood infrastructure and pass such costs on to land buyers and other end-users of land, lower-density development patterns will meet the test of economic efficiency (at least with respect to infrastructure costs). It may be mentioned that from the standpoint of community-level infrastructure, costs do not vary so much with residential density but with the degree of clustering and/or proximity to existing development.

d. Environmental Implication: The field survey reveals that, residential areas at Sabon-Gari, Zaria-wall, Tudun-Wada, Kwangila and Samaru axis encroached the water logs, while the constructed central drainage channel is not draining the water, the water logs blocked of road side drainage channels which is vulnerable to flooding. The attitude of residence of disposing refuse in the drainage channels and water logs in the sprawled areas apart from polluting the water, breeding mosquitoes, also created a serious unpleasant odour, capable of affecting the health of inhabitants.

A study by Abaje, Ati, and Iguisi in 2012, estimated that because of the increase in impervious cover in an area with flood plains, a flood event that should be expected once in 100 years could occur once every 5 years when the impervious cover reaches 25%, and could become an annual event when impervious cover reaches 65%, as such Zaria urban area has experienced increase in

built-up cover from 3.3% to 16.5% from 1976 to 2014, which if continue into the future without any proper measure taken may make the study area more vulnerable to flood events.

e. **Socio-economic Implications:** A critical visual interpretation of the land cover change maps reveals that the built-up were surrounded by agricultural land (basically vegetation and bare land cover), this implies that as built-up increases, vegetation and bare land decreases i.e. the change in built-up encroached on valuable agricultural land, as such the socioeconomic effect of land cover change in study area can be seen as follows;

- It poses a serious threat to agriculture
- The issue of food security
- Significant loss in the economy of food and income base for a reasonable amount of the population in the area under study.

CHAPTER FIVE

5.0 RECOMMENDATIONS AND CONCLUSION

5.1 RECOMMENDATIONS

It is recommended that the Kaduna State Urban Planning and Development Authority (KASUPDA) leads the adoption of GIS in Zaria by creating an urban growth analysis and monitoring unit within the existing structures of the Board. This unit will engage departments and units within the board and other ministries in carrying out the periodic analysis of urban growth and the dissemination of the information gathered to public and private organisations that have use for it. Examples of organizations with need for such information include utility providers, property developers, telecommunication providers, security agencies, fire department, the Health Ministry, and the Education Ministry. From the outcomes of the research, the tool will be beneficial to Zaria in the following ways.

(a) Planning of infrastructure and Urban Services Delivery

The ability of the cost of providing urban services and infrastructure can be very useful in the process of infrastructure planning, budgeting and priotization of interventions based on the objective identification of the areas of greatest need within the city. The rapid assessment of the dynamics of urbanization will also assist the development of proactive measures for providing infrastructure and services rather than the usual reactive approach of waiting until there is a gap to be filled which has been shown to be extremely inefficient.

(b) Planning and Growth Management

In Zaria Urban area, planning and development control is greatly hampered by the dearth of data especially up to date maps seen as cardinal requirements that determine the effectiveness and success of activities. GIS as a tool will provide fast and convenient access to updated mapped data and will also facilitate regular updates that will enable concerned authorities keep up with the pace of urban growth and development. This will have a positive impact on planning and growth management efforts.

5.1.1 Use of contemporary techniques

This calls for the adoption of remote sensing and GIS as a rapid appraisal technique by the planners in Zaria urban area to monitor the change processes within the urban areas. In the case of land cover, urban planners can adequately monitor changes with precision toward sustainable control and development.

5.1.2 Partnership towards sustainable environment

This requires the partnership between urban planners, managers and environmentalist for Zaria urban area, toward initiating environmental policies that would guarantee the emergence of sustainable living environments, these policies should be backed by appropriate implementation strategies. For instance, there is need to promote Urban Planning-Meteorological services, this close collaboration among the meteorologist and urban planner is needed to increase the awareness on the existing data base, Urban Weather conditions and sustainable environmental management.

5.1.3 Improving the competency of Planners/ Urban Managers

The planning Authority in most states are deficient in up-to-date base maps and satellite imageries of any form to guide planning action. Digital equipment and GIS tool as decision support tools are also lacking and the staff are generally without sufficient skills to undertake digital spatial analysis. To address these issues, the following are suggested:

(a) Skill and Education

Staff require training and education to enable them attain the minimum level of expertise and competence needed for the effective deployment of the GIS and Remote sensing in Zaria .Suitable candidates for this type of training are highly motivated middle cadre staff with Degree level education in Urban and Regional Planning, Cartography and Land Surveying.

(b) Equipment (Computer Hardware and Software)

The necessary hardware and software need to be acquired. Two properly calibrated computer workstations, one handle GPS unit, ArcGIS 10.1 software, Google Earth Software, other conventional software needed for proper functioning of the workstations and a reliable internet link are required as the initial investment.

(c) Managerial support and Goodwill

The management of KASUPDA needs to be adequately sensitized on the inherent benefits of the adoption of sprawl study in Zaria Urban area. This is because its goodwill and support is a pre-requisite to the successful and sustainable utilization of the tool within the framework of the day to day operations of the authority.

5.2 CONCLUSION

Urban sprawl has increasingly become a major issue in the global trend towards urbanization. Faced not only by developed countries but also by developing countries, and by large urban centers and medium and small cities alike, urban sprawl raises social and environmental concerns at the same time that shows a multiplicity of divergent trajectories that somehow defy the dominance of homogeneous characteristics around the world. This study examined the sprawl pattern of Zaria Urban Area using GIS and remote sensing as well as analyzing the causes of such sprawl by way of drawing implications of it and proffered solutions in controlling it.

According to the findings of this study, uncontrolled urban sprawl in Zaria has caused many changes in the land use along the major roads at the peripheral areas. The causes of having such widespread urban sprawl should be studied in order to develop strategies for controlling the city's growth. Some of the strategies and policies that can be used for controlling the urban sprawl are: creating a regional balance to reduce migration from rural areas to urban areas or the renewal and improvement of the central-historical fabric of Zaria urban area. This would cause the continuous settlement of population in these areas for living and would prevent migration from center to the suburbs. Also, the policy of infilling development can be used to provide for the future growth of the population, and for implementing strategies addressed to manage the construction in the undeveloped areas.

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